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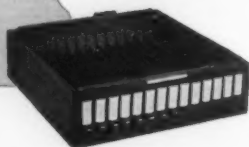
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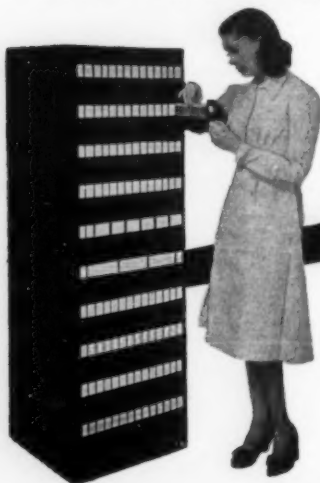
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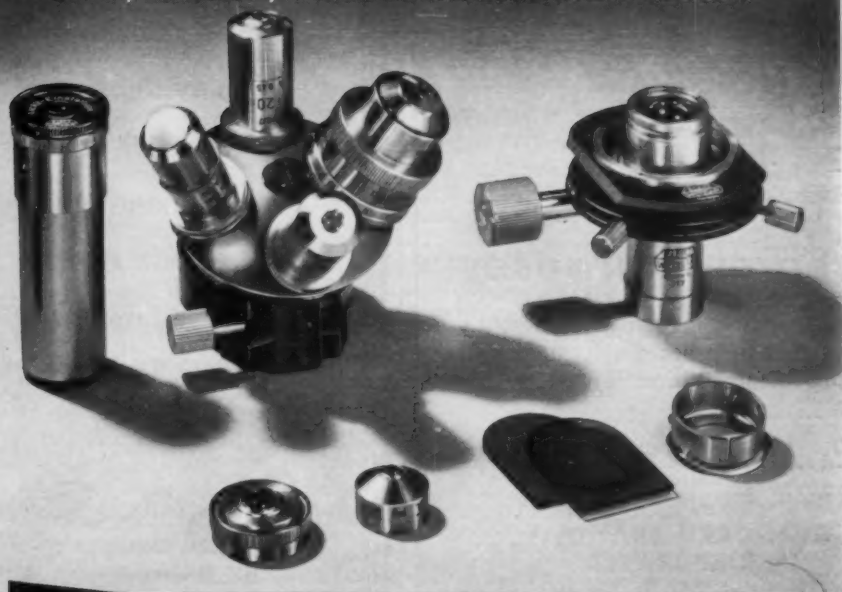
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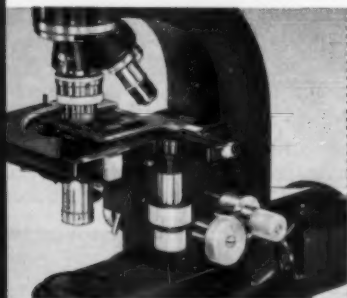
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A Retreat from Science?

There appears to be a growing number of editorials and articles lamenting the dwindling number of students who choose careers in science and engineering. Their authors cite such facts as these: the number of 1955 college graduates prepared as high-school teachers of science and mathematics was less than half the number in 1950; since 1900 the number of high-school students taking courses in physics has dropped from 19 percent of the total to less than 5 per cent; and there were only half as many engineering and science majors in the graduating class of 1955 as in the class of 1950.

These figures are accurate enough, but all of them require interpretation. In 1950 the peak of GI graduation was reached. Not only did more students finish college in that year than in any other before or since, but a larger than usual percentage of graduates were men. Given both the abnormally high total and the unusual sex ratio of 1950, it had to be expected that there would be smaller totals in following years and that the decrease would be greater in fields in which men predominate than in those in which men are a minority. Thus the comparison between the 41,000 men who earned bachelor's degrees in science (excluding engineering and other fields of applied science) in 1950 and the 22,000 who earned such degrees in 1954 looks like a rapidly dwindling supply of future scientists. But in percentage terms, each of these figures represents about 12 percent of all men in the corresponding graduating class. This comparison gives no support for fears that undergraduate men are fleeing from science.

In engineering, the situation is somewhat different. With some irregularities, engineering graduating classes grew, both absolutely and in relation to the total, from the beginning of the century to the end of World War II. Since 1950 there has been a large numerical drop, but this trend will be reversed as graduating classes get larger again. As a forecast for the future, it is perhaps less important that the number of graduates has fallen steadily since 1950 than it is that year after year since 1947 smaller and smaller fractions of all graduating men have specialized in engineering. The drop has been from 18 percent of male graduates in 1947 to 12 percent in 1954. Here is a trend to cause worry for the future.

While one must be cautious in interpreting some of the figures as evidence of a retreat from science, nevertheless there is a serious manpower problem in the scientific and technologic areas. There has been a decline since World War II in the percentage of students majoring in engineering. There has been a decline in the percentage of students preparing to teach high-school science and mathematics. There is a growing demand in both of these fields. A declining fraction of high-school students is getting adequate preparation in physics, chemistry, and mathematics. These trends justify grave concern for the future supply of scientists.

In considering future supply and demand, a basic point is the accuracy and reasonableness of the statistical information on which plans and predictions are based. The most carefully analyzed figures justify serious concern. The issue is confused and the case for better science education is weakened by using figures that are easily attacked as abnormal, unrepresentative, or subject to alternative explanations.—D.W.

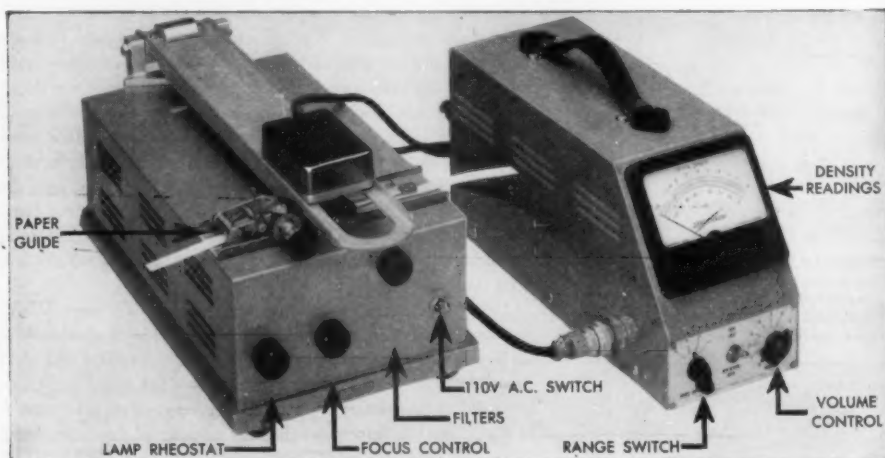
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Science and the Supernatural

George R. Price

Believers in psychic phenomena—such as telepathy, clairvoyance, precognition, and psychokinesis—appear to have won a decisive victory and virtually silenced opposition. Many other times during the past century such victory has seemed close, as evidence for the supernatural has been produced that has been found convincing by some of the world's leading scientists. But always on previous occasions, other investigators have made criticisms or conducted new tests, thereby demonstrating flaws in the evidence. What is unique about the present is that, during the last 15 years, scarcely a single scientific paper has appeared attacking the work of the parapsychologists.

This victory is the result of an impressive amount of careful experimentation and intelligent argumentation. The best of the card-guessing experiments of Rhine and Soal show enormous odds against chance occurrence, while possibility of sensory clues is often eliminated by placing cards and percipient in separate buildings far apart. Dozens of experimenters have obtained positive results in ESP experiments, and the mathematical procedures have been approved by leading statisticians (1).

I suspect that most scientists who have studied the work of Rhine (especially as it is presented in *Extra-Sensory Perception After Sixty Years*, 2) and Soal (described in *Modern Experiments in Telepathy*, 3) have found it necessary to accept their findings. Concerning the latter book, a reviewer (4) has written: "If scientists will read it carefully, the 'ESP controversy' will be ended." Against all this evidence, almost the only defense remaining to the skeptical scientist is ig-

norance, ignorance concerning the work itself and concerning its implications. The typical scientist contents himself with retaining in his memory some criticism that at most applies to a small fraction of the published studies. But these findings (which challenge our very concepts of space and time) are—if valid—of enormous importance, both philosophically and practically, so they ought not to be ignored.

Practical Applications for Extrasensory Perception

A common belief concerning ESP experimentation is that the results are interesting but are of small importance because of the great inaccuracy of perception. For example, Boring (5) writes in a discussion of Soal's work: "You see a 'brilliant' performance in telepathy is not so very striking after all. It is only 7 out of 25 instead of 5 out of 25. When people ask why these able percipients do not get rich by telepathing directors' meetings and playing the stock market with their superior knowledge, they do not know how small an advantage the best available telepathy of the modern age provides."

But card guessing by ESP, inaccurate though it is, nevertheless is a communication system by which information is transmitted. In the terminology of Shannon's "Mathematical theory of communication" (6), it is a case of a *discrete communication channel with noise*, "noise" representing whatever it is that causes errors. Information theory is unequivocal in showing that any system that has a finite capacity for transmitting information can (if we employ proper coding) transmit with any degree of ac-

curacy we may desire—say, as accurately as by telegraph, or more accurately—although it may take a long time to transmit a small amount of information with high accuracy.

In an ESP experiment where 6 hits are made in a run of 25, the channel capacity is about 0.0069 bits per trial; while 7 hits corresponds to 0.026 bits per trial, or 0.66 bits for a run of 25 trials (7). This means that (if each trial takes only a few seconds) information can be transmitted at a rate of several bits per hour and as accurately as by telegraph. Thus this appears to be a solution to problem No. 449 of the National Inventors Council, which involves "the development of a revolutionary new method of transmitting intelligence." Since ESP is independent of distance and requires no equipment (except possibly a watch for synchronization), it should be a most convenient means for transmitting information from an espionage agent in the Soviet Union directly to Washington or London.

Soal considers that there must be a selected human "sender" to aid in transmitting information, in addition to a selected percipient; but Rhine believes that a good percipient can perceive by clairvoyance in the absence of any sender as well as receive telepathically from virtually any person. Therefore, according to the findings of either Rhine or Soal, the suggestion made in the preceding paragraph is a fully practical one; but if Rhine's work is valid, then there are additional applications of enormously greater importance. In particular, while Soal has evidence that ESP may penetrate a few seconds into the future, Rhine has performed experiments of considerable ingenuity that show (in his opinion) that information concerning ESP cards can be received from as far as 10 days in the future (8; 9, pp. 73-75; 10, pp. 94 ff.; 11).

The general means for transmitting information accurately over a noisy channel is to send messages of high *redundancy*; that is, the information is repeated over and over again (in properly coded form) within the message. But events of great importance may be thought of as messages of high redundancy. Thus a nuclear bomb explosion would tell its story with enormous redundancy in terms of each of the hun-

Dr. Price is a research associate in the Department of Medicine, University of Minnesota, Minneapolis.

dreds of buildings destroyed and of the thousands of people killed (in excess of normal mortality). This suggests that ESP can be used for such purposes as accurate forecasting of a major catastrophe—assuming that Rhine's findings are valid. And this will be especially true if it is possible to use many percipients working simultaneously to increase accuracy.

Let us design a procedure to give a 10-day warning of a nuclear bomb explosion. ESP card designs are used, to make conditions closely similar to those Rhine employed in his precognition experiments. Cards are prepared that will react to the thermal flash of a nuclear explosion, so that the initial design will be bleached and a second design will develop. The cards are placed inside cameras with open shutters, surrounding a likely target area and directed upon various portions of the area. The cards are guarded and their symbols are kept secret. Each day several thousand selected percipients try to guess card symbols 10 days ahead. Guesses are analyzed in terms of each of the two possible correct symbols for each card.

If card symbols have been properly randomized, then, in the absence of ESP there will be no statistically significant pattern in the relationship between guesses and possible correct symbols. Thus, it will be virtually impossible to have a false alarm if ESP is not operating. Therefore, there will be strong presumption that there should be prompt evacuation, if some day, for cards corresponding to some contiguous area, guesses show a statistically significant relationship to the symbols-to-be-developed, while for the surrounding area there is a similar relationship involving the initial symbols.

Does this suggestion seem absurd? No. If information theory and Rhine's conclusions are both valid, this is a practical suggestion of high importance. Such a warning system would be far more effective and less expensive than radar. To be sure, it is true that Rhine's evidence for precognition is not so much in the form of large numbers of correct guesses, but rather it depends on certain statistical abnormalities in the pattern of correct guesses. But in general, any relationship between cards and guesses that is so highly improbable that it constitutes evidence for ESP can be made use of for transmission of information. And even if there is only 10-percent probability that Rhine's findings are valid, it is still the clear duty of appropriate government officials to investigate this possibility promptly and thoroughly.

Furthermore, contemporaneous clairvoyance can also be put to work in many ways. For example, the arrangement of ore in a vein provides a form of re-

dundancy plus a means of checking against guesses not based on ESP—provided that we exercise a little ingenuity in the way we set up the guessing procedure.

In short, it appears that wherever parapsychology can yield extrachance results, we can find a way to put it to practical use.

Hume's Argument Concerning Miracles

Now it happens that I myself believed in ESP about 15 years ago, after reading *Extra-Sensory Perception After Sixty Years*, but I changed my mind when I became acquainted with the argument presented by David Hume in his chapter "Of miracles" in *An Enquiry Concerning Human Understanding*.

Hume's argument runs as follows: "A miracle is a violation of the laws of nature; and as a firm and unalterable experience has established these laws, the proof against a miracle, from the very nature of the fact, is as entire as any argument from experience can possibly be imagined. . . . no testimony is sufficient to establish a miracle, unless the testimony be of such a kind that its falsehood would be more miraculous than the fact which it endeavours to establish. . . ."

Hume illustrated as follows the spirit in which he thought his argument should be employed: "You would in vain object to me the difficulty, and almost impossibility, of deceiving the world in an affair of such consequence . . . with the little or no advantage . . . from so poor an artifice: all this might astonish me; but I would still reply that the knavery and folly of men are such common phenomena, that I should rather believe the most extraordinary events to arise from their concurrence, than admit of so signal a violation of the laws of nature."

And also: "Where shall we find such a number of circumstances, agreeing to the corroboration of one fact? And what have we to oppose to such a cloud of witnesses, but the absolute impossibility or miraculous nature of the events which they relate? And this, surely, in the eyes of all reasonable people, will alone be regarded as a sufficient refutation."

Long before Hume, a similar point of view was taken by the Greek writer Lucian (12): "To defend one's mind against these follies, a man must have an adamant faith, so that, even if he is not able to detect the precise trick by which the illusion is produced, he at any rate retains his conviction that the whole thing is a lie and an impossibility."

And Tom Paine, a little after Hume, stated the same argument succinctly (13): ". . . is it more probable that nature should go out of her course, or that a man should tell a lie?"

Improbability of the Supernatural

My opinion concerning the findings of the parapsychologists is that many of them are dependent on clerical and statistical errors and unintentional use of sensory clues, and that all extrachance results not so explicable are dependent on deliberate fraud or mildly abnormal mental conditions.

The first step in applying Hume's argument would preferably be to make a numerical estimate of the *a priori* improbability of ESP. But unfortunately, it appears that scientific philosophy has not yet developed to the point where this is possible. This is regrettable, yet we should consider that if the problem were so simple as to permit numerical calculation, then this controversy would perhaps never have arisen.

Since I cannot prove, all I can do is try to convince by showing that ESP is incompatible with current scientific theory. It is sometimes asked: With what scientific laws does ESP conflict? But the conflict is at so fundamental a level as to be not so much with named "laws" but rather with basic principles. C. D. Broad has presented an excellent analysis showing that the psi effects are incompatible with nine "basic limiting principles" involving our fundamental concepts of space, time, and causality (14). I accept his analysis and incorporate it as part of the present argument.

Broad's discussion is too long to summarize here, so instead I shall list several incompatibilities of psi phenomena, described in a less fundamental manner. (i) ESP penetrates the future even in situations where rational inference is powerless. (ii) ESP is apparently unattenuated by distance. (iii) Psi effects are apparently unaffected by shielding. They come from matter and interact with matter (control of dice in psychokinesis), so why do they not interact with matter in a shield? (iv) Dye patterns on cards are read in the dark: how does one detect a trace of dye without shining light on it? (v) Patterns on cards in the center of a pack are read without interference from other cards. (vi) We have found in the body no structure to associate with the alleged functions. (vii) There is no learning but, instead, a tendency toward complete loss of ability. (So far as I know, there is for this type of behavior no parallel among established mental functions.) (viii) Different investigators obtain highly different results. For example, Soal requires a telepathic sender, but Rhine finds this unnecessary.

The parapsychologists themselves have agreed almost unanimously that psi phenomena are completely incompatible with modern physics. The situation has been analyzed in detail and with excel-

lent logic by both Rhine (10, chap. 4; 15, chap. 12) and Soal (3, pp. 303-305). And Rhine has correctly stated (10, p. 94) that "Nothing in all the history of human thought—heliocentrism, evolution, relativity—has been more truly revolutionary or radically contradictory to contemporary thought than the results of the investigation of precognitive psi."

To be sure, some scientists have argued that there may be no incompatibility. For example, see a recent paper on "Parapsychology and dualism" by Walker (16). And Boring (5) writes: "All you have got yet for extrasensory perception is an observed difference between two frequencies, between hits and misses, and a great deal of ignorance as to what causes the difference. Ignorance does not overthrow old concepts." But it seems to me that this is equivalent to arguing: "So you have seen a man turn into a small bat and fly away, and you think that this is evidence for the existence of vampires? Nonsense. All you have got is a difference between two patterns in which photons strike the retina, and a great deal of ignorance as to what causes the difference. Ignorance is not evidence." I feel that R. H. Thouless described matters aptly when he said (17): "I suggest that the discovery of the *psi* phenomena has brought us to a . . . point at which we must question basic theories because they lead us to expectations contradicted by experimental results."

If, then, parapsychology and modern science are incompatible, why not reject parapsychology? We know that the alternate hypothesis, that some men lie or deceive themselves, fits quite well within the framework of science. The choice is between believing in something "truly revolutionary" and "radically contradictory to contemporary thought" and believing in the occurrence of fraud and self-delusion. Which is more reasonable?

But the parapsychologists usually reply that we should accept both science and the supernatural. Although these may not fit together within a single scheme of things, we can imagine two separate systems, each compatible within itself. Why should we not accept dualism? To answer this here, I must try to compress a complex argument into minute space. The answer is: because past experience shows that dualistic reasoning has usually been comparatively unsuccessful in making predictions concerning observable phenomena.

Experience is all we have available as a guide to the future. As Reichenbach has pointed out, even when we consider magic phenomena, we must still base our expectations on inductive reasoning from past experience (18). From our experience we have derived certain generalizations concerning observable phenomena.

(Some of these we term *laws of science*, while others are so fundamental that we rarely name them.) In addition, we are able to make other generalizations concerning these first generalizations, for an enormous amount of pertinent data has accumulated. Thus, experience shows that scientific laws often fail when they are extended to a new range of size, like atomic size, but scientific laws do not fail in association with particular people.

For example: Suppose a physics student reports that he has found the wavelength of the red cadmium line to be 2 millimicrons greater than the accepted value. Now we cannot in any way at all prove that there do not actually exist some human beings whose presence can cause real, experimentally verifiable changes in physical constants—just as we cannot prove that the universe will not come to an end tomorrow. But our past experience suggests that the most profitable attitude for us will be to assume that the student made an error.

In the same way, we cannot prove that psi phenomena do not occur. Maybe in the presence of a "sensitive" the basic limiting principles no longer limit. But all our experience suggests that it will be more profitable for us to assume that the old generalizations are still valid, and that the findings of the parapsychologists are to be explained on the old, familiar basis of human error.

The Essence of Magic

We now imagine a new critic, who speaks to us as follows: "This is all very well, and I concede that psi phenomena appear to me most strange and improbable, but a half-century ago I would have felt the same way concerning relativity. Does not any radically new complex phenomenon appear as baffling and improbable as ESP?"

What is required is a test to separate reported findings toward which we should be narrow-minded from those toward which we should be receptive. What is the fundamental difference between the natural and the supernatural? What is the essential characteristic of magic?

Let us compare scientific and magical methods of table levitation (19). A scientist sits in his living room and says: "Table, rise." His speech pattern is portrayed on the screen of a visible speech apparatus. Phototubes observe the pattern through masks of appropriate shapes. A switch is closed, turning on an enormous electromagnet on the floor above. This attracts an iron plate concealed within the table top, and the table rises to the ceiling.

Similarly, the magician says: "Table, rise." And the table rises. The difference

is that there is no iron plate, no electromagnet, no switch, and no speech interpretation apparatus.

Now a scientist can accept the absence of the iron plate; it is conceivable that there can exist sharply localized forces attracting wooden objects. He can even accept the absence of the magnet. What he cannot accept is the absence of the speech interpretation apparatus and the switch. New forces can be fitted into a scientific scheme of things. What cannot be made to fit is the *intelligent* manner in which the force is turned on and *directed* to act upon the table.

In the scientific process, each successive detail is provided for. In the magic process, there are just the wish and the result, and all intermediate steps are omitted. The essential characteristic of magic is that phenomena occur that can most easily be explained in terms of action by invisible intelligent beings (20). The essence of science is mechanism. The essence of magic is animism. The way of science is to build a television system and a radio-controlled robot manipulator and have the manipulator cut a pack of cards at the 12th card and hold it up to the television camera. The way of magic is to sit in a chair with eyes closed and vaguely wish to know the identity of the 12th card down in a certain pack 100 miles away; and then the answer pops into one's mind.

Suppose that some extraordinary new phenomenon is reported: should we be narrow-minded or receptive? The test is to attempt to imagine a detailed mechanistic explanation. Whenever we can imagine any sort of detailed explanation without introducing incorporeal intelligences, we should be prepared to regard the phenomenon open-mindedly. For this test it is not necessary that our explanation be simple, reasonable, or usable in making predictions. For example, any nuclear physicist could postulate a score of new forces, transition rules, and such, and so produce a complete theory of the atomic nucleus. Such a theory would be scientifically worthless, yet it would still satisfy the proposed test.

But with the phenomena of parapsychology, the situation is entirely different. Suppose that we attempt to describe mechanisms. Let us start with ESP tests at a distance of 100 miles or so, and let us feel free to imagine strange, fantastic forces without limit. Assume that we have under our control an invisible observation device that we can send in any direction at the speed of light. How do we go about locating a pack of cards 100 miles away? Would we guide ourselves by landmarks—or what? And would we not have to perceive with great accuracy in order to find the target? But how can we be accurate in perception of landmarks when we are grossly inaccurate in

reading the target card? And how do we go through this locating process without any consciousness of it?

The special linkage that seems to exist between a percipient and the proper target card or telepathic sender is the sort of linkage that is characteristic of magic. In Greek mythology, the life of Meleager was linked to a piece of wood, and when his mother threw it on a fire, he perished far away. Or an African witch doctor makes a clay image and buries within it nail parings and bits of hair, and when the image is destroyed a man dies in London. Or a curse is uttered, and some magic influence goes to seek a distant victim.

Next, consider the process of "reading down" through a pack of ESP cards. How do we accurately locate card No. 12? How do we tell that we are reading the pattern on the face of card 12 and not confusing it with the back of card 13? How do we detect dye molecules in the dark? Do we subject the electrons to the same transitions that they would undergo in light, or do we employ different means of analysis? And how do we analyze just the dye and not the paper? Imagine anything you wish. Feel free to invent a new topology and a dozen different types of fields. But just describe the process in detail.

For other mental processes, conscious or subconscious, we can describe (or at least imagine) successive steps. We can describe in detail the steps involved in the creation of a great poem (21) or a mathematical theory (22). We can explain subconscious processes such as the regulation of our heartbeat. Where information is missing, we can guess. But with the supernatural, all is different.

Moreover, how does the information get into a brain? How is it converted into electrochemical changes within neurons? And suppose that translation into neural impulses is already accomplished; then how are these signals to be interpreted? Pitts and McCulloch (23) have suggested neural patterns in human brains for interpretation of visual and auditory stimuli—but can anyone describe a conceivable nerve network for interpreting the raw data of ESP?

And finally, what conceivable way is there to explain precognition?

There is no plausible way to explain these details except in terms of special intelligent agents—spirits or poltergeists or whatever one wishes to call them. The proper target card is selected by a spirit. A spirit implants information in the brain in proper electrochemical form. The ability disappears when the spirit tires of working with a particular person. In short, parapsychology, although well camouflaged with some of the paraphernalia of science, still bears in abundance the markings of magic.

To be sure, the world of magic is a lovely world. To make a silent wish—and mysteriously influence the fall of dice. To sit with closed eyes while knowledge of the future strangely floats into the mind. These possibilities have for us the charm of childhood days, when we could fall asleep on Christmas Eve and in the morning find a tree hung with presents—like some Arabian Nights adventurer who fell asleep in a hovel and awoke in an enchanted palace. But the way of science is different. To construct a building, each brick and board must be fitted into place by human beings—not by jinn who answer the rubbing of a lamp. If our soldering is careless, our circuit will certainly be noisy; and if we make our seals poorly, our vacuum system will assuredly leak—and no incantation will help.

Fraud and Error

Following the publication in 1935 of Rhine's first book (24), numerous papers appeared in American psychological journals pointing out possibilities of clerical errors and sensory clues and criticizing the statistical methods. These criticisms have been reviewed in detail by Pratt *et al.* (2). Later attacks of this sort were made by Nabours (25), Skinner (26), Rawcliffe (27), Brown (28), and—most recently and authoritatively—by Soal himself (3).

I believe that many of these criticisms were justified, but I am also completely convinced that some of Rhine's work and most of Soal's can be accounted for by no conceivable combination of such explanations.

What about fraud?

The parapsychologists speak of that possibility with utmost scorn: "We have done all that we can when the critic has nothing left to allege except that the investigator is in the trick. But when he has nothing else to allege he will allege that" (29). The hypothesis of "extensive and collusive fraud has yet to be responsibly suggested" (30). "The notion of such wholesale conspiracy would be to most students more fantastic than the ESP hypothesis" (2, p. 166).

Surprisingly, it is not only believers who are reluctant to imagine fraud, but virtually all skeptics as well will prefer almost any other type of explanation. It would be tedious for me to cite statistics to show that "the knavery and folly of men" are indeed "common phenomena," for everyone is aware of this—in an intellectual way. But when we try to imagine knavery and folly in connection with a particular individual, we encounter a surprising emotional blockage, and the possibility seems unreasonable. And thus we find skeptics searching for every

other conceivable sort of explanation—proposing absurd systems of involuntary whispering, or indulging in the metaphysical acrobatics of arguing that ESP cannot occur because it involves a "negative hypothesis"—while the one explanation that is simplest and most in accord with everyday experience is dismissed as inconceivable. It is almost as though we give this answer to Paine: "We detest the thought that nature would go out of her course, but we will believe that or anything else rather than believe that a man would tell a lie."

It is particularly difficult for us to conceive of dishonesty in any situation where fraud would have to be complex and daring. For example, most people find it easier to imagine that some assistant may have occasionally cheated in an ESP experiment, than to suppose that a chief investigator could have deliberately designed an entire investigation fraudulently. Similarly, in the field of the "confidence game," the victim might be capable of suspecting one or two of his new "friends" as crooks, except that he cannot imagine that the entire stock exchange or gambling club to which they introduce him is an artifice, with the manager, employees, and even patrons all "in the trick."

A good antidote against our curious mixture of credulity and incredulity is to become acquainted with some of the elaborate deceptions of the past. Books that describe fraudulent production of supernatural phenomena have been written by Houdini (31), Podmore (32), Dunniger (19), Jastrow (12), and Rawcliffe (27). Confidence games involving expert understanding of the psychology of credulity are described by MacDonald (33). And MacDougall (34) discusses the history and psychology of hoaxing.

There is a literature on the supernatural, just as there is a literature of chemistry and physics, and the scientist who ignores this literature and depends on his pure reasoning powers in evaluating reports of psychic phenomena is at a disadvantage. A little acquaintance with the careful studies of men like Podmore and Houdini will give one a broader point of view and a clearer understanding by which to evaluate modern parapsychology. For example, the man who knows that the Davenport brothers employed as many as 10 confederates in a single séance (31, p. 23) should not think it unreasonable when I presently suggest that I would want seven or eight confederates in order to imitate 170 Soal sittings. And the reader who finds that he cannot conceive of the possibility that any leading modern parapsychologist could be fraudulent should compare his attitude with certain earlier judgments concerning the honesty of mediums. Consider, for example, Houdini's report that Ar-

thur Conan Doyle told him that "he did not believe any of 'the nice old lady mediums' would do anything wrong and it was just as unlikely for some old gentleman, innocent as a child unborn, to resort to trickery" (31, p. 142). Or consider William Crookes's opinion of Daniel Home (35): "To those who knew him Home was one of the most lovable of men, and his perfect genuineness and uprightness were beyond suspicion . . ." (Home was the most brilliant and successful of all mediums, and his patrons included the rulers of France and Russia. He could elongate his body by 11 inches, levitate himself and float around séance rooms near the ceiling, and perform numerous other miracles.)

History shows numerous men of great intelligence victimized by the simplest and most transparent trickery. Therefore, it is wisdom on our part to be aware that the rules by which we actually protect ourselves against dishonesty are little more than rules-of-thumb telling what to do in particular situations ("Don't gamble with strangers." "Know your endorser." "Always have a lawyer read the contract."), while our general principles for detection of dishonesty are mostly prejudices with little value. The courts, as a result of vast experience and utter necessity, have worked out a moderately satisfactory system of rules of evidence; but the psychological theorizing by which in daily life we judge innocence or guilt is valueless when it is applied to the work of a clever deceiver.

There is a certain stereotype of appearance and behavior that we associate with honesty, and a second stereotype that we associate with dishonesty—and successful swindlers are wise enough to imitate the former stereotype. "O what a goodly outside falsehood hath!" And so it is folly for us to survey the actions of a brilliant man and say: "This looks honest. If he were a charlatan, he would have done thus and so." Let us remember that those who seek to deceive us possibly are smarter than we are and probably have had more practice in simulating honesty than we have had in detecting dishonesty.

The wise procedure, when we seek to evaluate probability of fraud, is to try to ignore all vague, psychological criteria and base our reasoning (i) on such evidence as would impress a court and (ii) on purely statistical considerations. And here we must recognize that we usually make a certain gross statistical error. When we consider the possibility of fraud, almost invariably we think of particular individuals and ask ourselves whether it is possible that this particular man, this Professor X, could be dishonest. The probability seems small. But the procedure is incorrect. The correct procedure is to consider that we very likely

would not have heard of Professor X at all except for his psychic findings. Accordingly, the probability of interest to us is the probability of there having been anywhere in the world, among its more than 2 billion inhabitants, a few people with the desire and the ability artfully to produce false evidence for the supernatural.

Has There Been a Satisfactory Test?

What is needed is one completely convincing experiment—just one experiment that does not have to be accepted simply on a basis of faith in human honesty. We should require evidence of such nature that it would convince us even if we knew that the chief experimenter was a stage conjurer or a confidence man. Has there been any single ESP experiment that would stand up if it were examined from this point of view?

Had I but space enough, I would analyze here all the major experiments of all the major investigators. But I do not have. I might select Rhine's work for discussion, but it apparently has not impressed critics nearly so much as Soal's. In fact, there are some indications that it has not impressed Soal himself very much (36, 37). But Soal's own work has been found convincing by eminent men of great intelligence. G. Evelyn Hutchinson (38) wrote concerning the Shackleton experiments that "they appear to be the most carefully conducted investigations of the kind ever to have been made," and that "Soal's work was conducted with every precaution that it was possible to devise." C. D. Broad wrote (39): "There was already a considerable mass of quite good experimental evidence for telepathy, e.g. in the work of Dr. Rhine and his colleagues at Duke University, but Dr. Soal's results are outstanding. . . . The precautions taken to prevent deliberate fraud or the unwitting conveyance of information by normal means are described in great detail, and seem to be absolutely water-tight."

So in the next two sections, I shall describe and analyze Soal's experiments. But I hope that readers will not search in these sections for psychological clues with which to bolster skepticism or belief. For example, one may note that Soal was originally himself a partial skeptic and from this conclude that he must be honest. Or conversely, one can reason: "The fact that for the Stewart series Soal altered the position of the screen aperture, raising it to eye level, suggests that he arranged conditions so that he could observe cards reflected in eyeglasses." But the wise course is to try to avoid such ethereal speculations. At best they may be treated as hunches to guide detectives but not as evidence to

be presented in court. Such trivia would hardly be considered in a trial of a pick-pocket, so they should not be offered as evidence for deciding profound cosmological questions.

This is the type of testimony that impresses a court (40): "On April 17, 1910, at a séance given by Eusapia Palladino in New York City at the home of Professor H. G. Lord, I crawled under some chairs and lay with my face on the floor within eight inches of the leg of the table at the left side of the medium, and a foot came from underneath the dress of the medium and placed the toe underneath the left leg of the table, and pressing upward, gave it a little chuck into the air." Since I know of no evidence of this nature showing that Soal did or did not cheat, all that I am trying to do in the next two sections is to demonstrate that Soal *could* have cheated if he wanted to, and that therefore we should demand better evidence than his before we believe in the supernatural.

Soal's Experiments

In his early work as a psychic investigator, Soal published excellent papers reporting negative findings and showed himself to be a meticulous and ingenious experimenter, expert at uncovering trickery (41). Then, allegedly, in 1939 he recalculated some old data and found that two people he had tested unsuccessfully for contemporaneous telepathy had actually been making highly significant precognitive scores (42). These were Basil Shackleton and Mrs. Gloria Stewart. Shackleton was then studied in 40 sittings dating from January 1941 to April 1943 (43). Mrs. Stewart was investigated from August 1945 to January 1950, in 130 sittings (3, pp. 199-337; 37, pp. 34-56; 44).

The complex experimental procedure devised by Soal is most conveniently described as a cryptographic process (although Soal himself does not employ this terminology). An original number sequence of 50 terms (randomly selected from the digits 1 to 5) is enciphered by use of a key to yield a letter sequence. The latter is transmitted telepathically to a percipient, who records his guesses. This received letter sequence is deciphered by use of the key to yield a second number sequence, which is compared with the original. The cipher system is simple, one-digit substitution, and the key is a permutation of the letters E G L P Z (or other symbols). The total process is illustrated in Table 1, as it might occur with the following key:

1 2 3 4 5
L P Z G E

The steps in the process are carried out

by (i) the "EA" (the Experimenter associated with the Agent), who shows the original sequence, one digit at a time, to (ii) the Agent, who performs the enciphering and then telepathically transmits to (iii) the Percipient. At the close of a sitting, all received sequences are deciphered and then scored for "hits," as is shown in column VI, which indicates postcognitive ("−2" and "−1"), contemporaneous ("0"), and precognitive ("+1" and "+2") hits.

The EA and Agent sit on opposite sides of a small table, separated by a screen with a 3-inch square aperture. (The center of the aperture was 13 inches above the table top in the Shackleton sittings and 18 inches above the table in the Stewart sittings.) Resting in a rectangular box on the table on the Agent's side is a row of 5 code cards bearing animal pictures or initial letters (for example, Elephant, Giraffe, Lion, Pelican, Zebra). The open face of the box is toward the Agent, so that the code cards are shielded from the EA and others. The Percipient is in another room.

In a typical experiment, at each trial, the EA displays at the aperture the digit indicated by a random number list (column II), and then he calls out to the Percipient the serial number of the trial (column I). Then the Agent briefly raises and glances at the code card in the indicated position, and the Percipient writes his guess. For example, at trial No. 8 in Table 1, the EA displayed the digit 2 at the aperture and called out "eight." The Agent then raised the card in position 2 (second from the left) and glanced at the picture of a pelican. The Percipient wrote down the letter G, which was a "+1" precognitive hit.

Sittings were usually composed of 8 runs of 50 trials. At "normal" rate of calling, each trial required between 2 and 3 seconds. At the start of each run, the Agent or an observer shuffled and arranged the code cards out of sight of the EA, thereby changing the key. After each 50 trials, the code-card order was re-

corded. Following the last run, the Percipient's guesses were deciphered by the appropriate key, and hits were counted.

There were a number of variations. In most experiments the original sequence was taken from a list provided by Soal, but occasionally lists were computed by outsiders and were given directly to the EA at the start of the experiment. At a few sittings the number sequence was generated by the EA during the run by drawing colored counters from a bag or bowl. Usually the sitting was in the Percipient's home, but occasionally other locations were employed; and in six sittings Mrs. Stewart made her guesses in Antwerp, with Agents in London.

In the Shackleton series, almost all the extrachance results were produced with either "R.E." or "J.Al." as Agent. With the former, most successes were "+1" precognitive hits. In 5367 "+1" trials at "normal" rate of calling with R.E. as Agent, Shackleton scored 1540 "+1" hits, for a mean of 13.77 per run of 50 trials (45). Usually, with J.Al. as Agent, both pre- and postcognitive guesses yielded more than 13 hits per run; hits were ordinarily "−1" and "+1," but changed to "−2" and "+2" when the calling rate was doubled. Thirty-one sittings yielded extrachance results, and at all of these both Soal and Shackleton were present, plus at least one of the following: Mrs. Goldney, J.Al., and R.E. In addition, at 23 of the 31, one or more additional persons were present. Usually these took the roles of EP (Experimenter watching the Percipient) or EA, or watched the Agent; but two worked successfully as Agents.

In the Stewart series, 30 persons were tested as Agents, and 15 were successful. Total score for 37,100 trials by standard procedure was 9410 "0" hits, for a mean score of 12.68 hits per run of 50. In these experiments Soal usually took the role of EA. The usual procedure was for the Agent to shuffle the cards and then arrange them face up and stare at them for 30 seconds. Then they were turned over, and during the run the Agent

tapped the indicated card on the back instead of lifting it. The cards usually bore initial letters about 2 inches high instead of animal pictures (46).

Analysis of Soal's Work

Before I continue, it should be clearly understood that I am not here stating that Soal or any of his associates was guilty of deliberate fraud. All that I want to do is show that fraud was easily possible.

I do not claim that I know how Soal cheated if he did cheat, but if I were myself to attempt to duplicate his results, this is how I would proceed. First of all, I would seek a few collaborators, preferably people with good memories. The more collaborators I had, the easier it would be to perform the experiments, but the greater would be the risk of disclosure. Weighing these two considerations together, I'd want four confederates to imitate the Shackleton experiments. For imitating the Stewart series, I'd probably want three or four—although it is impossible to be certain, because the Stewart sittings have not been reported in much detail. In recruiting, I would appeal not to desire for fame or material gain but to the noblest motives, arguing that much good to humanity could result from a small deception designed to strengthen religious belief.

The next step would be to devise procedures. Like a competent medium, I would want several alternatives available, so that any skeptic who suspected one procedure could be confronted by a repetition performed under conditions making the suspected procedure impossible. One main group of procedures would involve matching a prepared random number sequence to a letter or number sequence previously memorized or written out by the Percipient. At about 90 percent of my sittings, the original sequences would be taken from lists provided by me. Here are a few of the possibilities:

Procedure 1. The Percipient and the Agent are "in the trick." The Agent arranges the code cards as previously directed by me, and the Percipient writes down a memorized sequence or takes a list from a drawer if no outsider is watching him. (This would be a preferred procedure in most experiments except when an outsider determined the order of the code cards. It could succeed with outsiders as EA and EP.)

Procedure 2. The Percipient and the Agent (or the EA or an observer) are "in the trick." The code card order is determined by an outsider. The Agent (or the EA or an observer) notes this order, classifies it into 1 of 6 groups, and signals the group number to the Percipient be-

Table 1. An example of the transformations involved in a typical telepathy experiment of the Soal type.

I Trial number	II Original sequence	III Enciphered sequence	IV Received sequence (guesses)	V Deciphered sequence	VI Type of "hit"
1	3	Z	G	4	
2	5	E	E	5	0
3	1	L	E	5	−1, +2
4	4	G	P	2	
5	5	E	L	1	−2, +1
6	1	L	Z	3	
7	2	P	P	2	0, +1
8	2	P	G	4	+1
9	4	G	Z	3	+1
10	3	Z	P	2	−2

fore or after the run. Only 2.6 bits of information are needed to designate a choice of 1 out of 6. For example, the Agent glances at the backs of the cards and then says: "Ready." "All ready." "Yes, I'm ready." "Yes, ready."—And so forth (47). The Percipient then takes from a drawer the designated guess sheet, which is already filled out in his hand writing (48). (If the Agent is an outsider, the EA or an observer can note the card order when it is recorded at the end of the run and signal it in the conversation then.)

Procedure 3. The Percipient and the Agent are "in the trick." The Agent notes the card order and signals it (6.9 bits for the 120 possible permutations) before the start of the run. The Percipient has memorized a number sequence, and he uses the card order to encipher each number mentally. (This can work with outsiders watching both the Agent and the Percipient and shuffling the code cards; or if the Agent is an outsider, the signaling can be done by an observer who shuffles the cards.)

Next consider some of the procedures that could be used even when the number sequence was not known to me in advance:

Procedure 4. The Percipient and the Agent are "in the trick." They have copied or memorized the same lists of letter symbols. During the run the Agent records (concealed by the box) the numbers corresponding (precognitively) to the letters that he knows the Percipient is guessing, and at the end he rearranges the code cards to give the desired degree of success. For example, with a record like that shown in Fig. 1, the Agent could see that card arrangement LEGZP will yield a large number of hits. (This procedure would be particularly useful when the EA was an outsider.)

Procedure 5. The Percipient and the EA are "in the trick." The EA learns the order of the code cards and signals information to the Percipient during the run. The Percipient has memorized a random sequence of letter symbols. The EA, in calling out the serial numbers, slightly alters his voice or timing a few times during each run (5 times per 50 trials to give 14 hits). Ordinarily the Percipient is to guess at random, but at each signal he writes down the next letter on the memorized sequence. (I would use this method particularly in experiments when an outsider who wore glasses served as Agent. Then the preferred experimental arrangement would be that in which the cards are turned face up for 30 seconds, the screen aperture would be located as it was in the Stewart sittings, and the lighting would be so arranged that the EA could see the cards by reflection in the Agent's glasses.)

Procedure 6. The Percipient plus the

EA, the Recorder, or the Agent are "in the trick." In runs where the number sequence is generated by counters, I would have the EA draw counters of the needed color at particular points, or the Recorder could keep false records of counters drawn. And in some experiments, procedures, 1, 4, or 5 could be used.

The procedures that could give the highest degree of success, and that thus would be chosen when I wanted simultaneous "-1" and "+1" or "-2" and "+2" successes, are procedures 1 and 3. Any of the others would be more than adequate for scores of 12.68 hits per run of 50, or 13.77 hits in 48 trials. For long-distance experiments, procedures 1 and 4 would work. Or I could employ procedure 2 by telephoning the Percipient after the sitting to tell him which lists to mail in.

Many other procedures are possible. The six chosen for description were selected as samples of what can be done by simple means. Mental abilities required are similar to those needed for playing bridge competently, except that some collaborators would need a little memory training. Use of special apparatus or of collaborators with the abilities of a good stage conjurer would open up numerous new possibilities. Thus it should be clear that Soal's work was *not* conducted "with every precaution that it was possible to devise." The work would have been enormously more nearly fraudproof if Soal, instead of employing his highly complex arrangement, had simply had many different Agents "send" directly from lists prepared by outsiders and given directly to the Agent at the start of each run. And the examples to be given presently will show what precautions can be devised if one really wants to devise precautions.

Why Has There Been No Satisfactory Test?

Both Soal and Rhine have demonstrated ESP before intelligent "open-minded" outside observers, but what is needed is something that can be demonstrated to the most hostile, pig-headed, and skeptical of critics. Why has there been no such demonstration? Because when onlookers are hostile, "sensitives" allegedly lose their paranormal abilities. This excuse is an old one, long employed by spiritualist mediums, but contemporary parapsychology has modernized it with a touch of poetry. Thus Rhine asks (15, p. 246): "Would you expect, if we had a young poet here, that we could send him up to your university to write some poems for you while your committee sat staring fixedly at him to see that he did not slip them from one of his pockets?" And Soal argues (3, pp. 51

f.): "But one would not expect even a poet to produce a good poem if he were surrounded by people who, he felt, viewed his activities with half-concealed scorn or humorous contempt. The best he could do would be to churn out a few passable verses from which the informing spirit of poetry would be absent."

There are two replies to this excuse. The first is that it is false. It appears plausible to us because nowadays we tend to regard poets as rather erratic, neurotic beings. But in other periods, when it was expected of every educated man that he be able to write competent poetry, such reasoning would not have seemed convincing. Of course there are poets who require solitude for work, just as there are bridge players who are upset by kibitzers; but one would hardly imagine, say, Sidney or Raleigh or Byron suddenly starting to write like Edgar Guest because people were staring at him.

Poetic creation, as analyzed by John Livingston Lowes in his monumental study of Coleridge (21), is strikingly similar to mathematical creation, as described by Jacques Hadamard in his brilliant little book on *The Psychology of Invention in the Mathematical Field* (22). We expect a young mathematician to be able to do creative mathematical thinking before a hostile examining committee, and a poet or any other kind of thinker can do as well. Rhine writes (9, p. 141): "All the fickleness and skittishness of ESP and PK will find their counterparts in the fine arts, in the realm of the Muses." But this is not correct. There is no established human ability whatever that shows the fickleness of ESP.

Such is the first reply to the excuse of Rhine and Soal. And the second reply is that it is perfectly possible to set up fraudproof tests permitting "sensitives" to work anywhere they wish, completely alone or with whatever company they desire, and yet with the experiments subject to the most searching scrutiny at all essential points.

In other days, numerous "sensitives"

	1	2	3	4	5
E	//	///	//	//	/
G	//		///	//	///
L	///	///	//	/	/
P		//	//	/	///
Z	///	//	/	///	

Fig. 1. Type of record to be kept by an Agent employing procedure 4 for simulating telepathy. If the number sequence "12345" is replaced by the letter sequence "LEGZP," it will be seen that arranging the code cards in this order will result in 16 "hits."

willingly demonstrated their marvels before critical examining committees. In the 1870's, Daniel Home submitted to painstaking investigation by William Crookes. In the 1880's, a number of mediums appeared before the Seybert Commission of the University of Pennsylvania. Later, the British and American Societies for Psychical Research continued the type of investigations that had been started by the Seybert Commission. And from about 1880 to 1910, the great Eusapia Palladino made a specialty of holding séances before committees of scientists.

But a change came. Although scientists were often easily fooled, conjurers proved to be able foes of mediums. Houdini devoted the last years of his life to exposing mediums, and then this work was continued by Dunninger, who for many years defended the *Science and Invention* awards of \$21,000 for physical spirit manifestations that he could not duplicate by scientific means (49). So effective has such work been that nowadays we hear very little of the olden wonders like materializations or elongations, levitations or transportations. Such tricks are too risky, too easily exposed by skeptics with flashlights. Instead, today we are expected to marvel at vague statistical effects, minutiae that a conjurer would scorn to imitate on a stage. So little is claimed, and this little is demonstrated only to such restricted audiences and under such carefully controlled conditions and with so many excuses for failure available that it is quite difficult to prove that the little is actually nothing. Yet this can be done, I think.

Design of a Satisfactory Test

As scientists, what sort of evidence for ESP should we demand? This sort: one test of such nature that fraud or error would seem to us as improbable as the supernatural. Let us somewhat arbitrarily think of a committee of 12 and design tests such that the presence of a single honest man on the "jury" will ensure validity of the test, even if the other 11 members should cooperate in fraud either to prove or disprove occurrence of psi phenomena. Assume that the committee includes two experimental psychologists, two experimental physicists, one statistician, and three conjurers or other experts on trickery—all prominent men and all strongly hostile toward parapsychology, with that "adamantine faith" that Lucian recommended (50). Then probably most scientists would have confidence in the committee and would be prepared to believe in psi phenomena in preference to believing that the entire committee was dishonest or deluded. In addition, so that results would be acceptable to

parapsychologists, the chairman of the committee should be a person with a record of successes in psi experimentation, for it is claimed by West (51) and Soal (3, pp. 388 f.) that the personality of the chief experimenter may in some psychic manner determine success or failure in a psychic experiment.

To test Rhine's "sensitives," the simplest procedure is to prepare sealed packages of cards and mail them to Duke University to be examined by clairvoyants at any time and place they select, and then have them mailed back along with records of guesses. In preparing the packages, cards would be shuffled automatically by a series of machines and placed within opaque containers in such manner that no one could possibly have seen any card from the beginning of the shuffling. A good procedure for insuring against opening would be to place each set of cards in a small metal container, weld on a cover, and take photomicrographs of the weld—for it is probably impossible to counterfeit microscopic details. When the cards were returned, first the seals would be checked, and then packages would be cut open and cards fanned out by machine, with the jury watching and with a motion-picture camera recording everything.

For the type of findings made by Soal, the simplest and most fraudproof type of test would make use of the precognitive ability that Shackleton allegedly showed most of the time and that Mrs. Stewart allegedly showed for a brief time. With precognition, the only safeguards needed are that the "message" be generated in a way not subject to ordinary human control or prediction, and that guesses be recorded before the message is displayed. Imagine a radioactive sample of high activity, plus a scintillation counter with ring-of-five scaling circuit and indicator lamps corresponding to Soal's five animal symbols. An accurate timing circuit turns off the counter at set intervals. The circuitry is wired in such open fashion that inspection is easy. The apparatus is battery-powered and is placed in a shielded case, with nothing penetrating through the shield except windows to show the indicators. The percipient and the telepathic sender can be wherever in the world they wish, together or far apart, in the same room with the apparatus or across the ocean from it, alone or with whatever company they want. The guesses of the percipient (transmitted via radio or cable, if necessary) are indicated in some visible form, and a single motion-picture camera records both guesses and subsequent "calls" of the number generator.

It is also simple to test psychokinetic control of dice. While a motion-picture camera records everything, one or more dice are placed at the top of a chute or

in a throwing machine. Then a ring-of-six random number generator tells the psychic controller what number to wish for, and a few seconds later the dice are automatically released. The psychic controller can be in the same room, or anywhere in the world where telephone or radio can reach him.

For testing contemporaneous telepathy, symbols to be transmitted should be controlled by a random number generator, and the percipient could be anywhere in the world except close to the sender. However, it is exceedingly difficult to guard against all known communication means, especially since only a few bits of information need be transmitted per 25 trials in order to give extrachance results. For example, the sender might signal to a member of the committee by means of slight motions of his body, and the committee member could use a pocket radio transmitter to relay the information. I have worked out several procedures that appear to be reasonably fraudproof, but the required precautions are quite elaborate, and I am not sure that others cannot think of much simpler procedures, so I prefer not to take the space to describe my ideas here. No doubt clairvoyance, precognitive telepathy, and psychokinesis should be examined first, since it is so easy to test them. Then—if anyone is still interested in the question—contemporaneous telepathy can be tested.

Even now in 1955, paranormal findings continue to be published in England (52) and America (53), so it is reasonable for us to expect that both the British Society for Psychical Research and the Duke University Parapsychology Laboratory will gladly offer "sensitives" to be tested.

Conclusion

What sort of reply will the parapsychologists make to these criticisms? I have read answers they have made to others, and on that basis I might expect some of the following.

1) "Some interesting suggestions for further demonstrations of ESP have recently been made, but we consider that ESP was demonstrated beyond any reasonable doubt many years ago, and it is a waste of time to keep proving the same thing over and over again. However, there is much need for additional workers in the field, so we hope that Price will try his suggestions himself."

2) "Standards of experimentation in psi research are already far higher than those in most fields of science, so it is absurd to seek further improvement. Science would have made little progress if every chemistry and physics experiment had had to be performed before wit-

nesses and with numerous other precautions."

3) "A foolish attack has recently been made by an incompetent man who, to the best of our belief, has never published a single experiment in the field of parapsychology." (54)

4) "Unfortunately, I can furnish no one right at present for demonstrating ESP. However, I proved everything conclusively, with odds against chance of 10^{237} to 1, back in 19—."

But the only answer that will impress me is an adequate experiment. Not 1000 experiments with 10 million trials and by 100 separate investigators giving total odds against change of 10^{1000} to 1—but just one good experiment. And until such a demonstration has been provided, I hope that my fellow-scientists will similarly withhold belief. (55).

References and Notes

- See, for example, the press release by B. H. Camp, president of the Institute of Mathematical Statistics, quoted in the *New York Herald Tribune*, 16 Jan. 1938, sect. II-IV, p. 6.
- J. G. Pratt, J. B. Rhine, B. M. Smith, C. E. Stuart, J. A. Greenwood, *Extra-Sensory Perception after Sixty Years* (Holt, New York, 1940).
- S. G. Soal and F. Bateman, *Modern Experiments in Telepathy* (Yale Univ. Press, New Haven, Conn., 1954). I cite this book as "Soal," rather than as "Soal and Bateman," since large portions of it are taken almost unchanged from papers by Soal alone or by Soal and Goldney.
- R. A. McConnell, *J. Parapsychol.* 18, 245 (1954).
- E. G. Boring, *Am. Scientist* 43, 108 (1955).
- C. E. Shannon, *Bell System Tech. J.* 27, 379-423, 623-656 (1948).
- Channel capacity is given by:

$$\text{Bits/trial} = \log_2 5 + \frac{(N/25) \log_2 (N/25) + (25-N) \log_2 (25-N)}{100}$$
 where N is the mean number of "hits" per 25 trials ($N \geq 5$). (This formula applies strictly only to cases where in each trial there is equal probability of selecting any of the five symbols; thus it applies strictly to most of Soal's work but will be slightly in error for most of Rhine's work.)
- J. B. Rhine, *J. Parapsychol.* 6, 111 (1942); 9, 264 (1945).
- , *The Reach of the Mind* (Sloane, New York, 1947).
- , *The New World of the Mind* (Sloane, New York, 1953).
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- Quoted by J. Jastrow in *Wish and Wisdom* (Appleton-Century, New York, 1935), p. 25.
- T. Paine, *Age of Reason*; the quotation comes a few pages before the end of part I.
- C. D. Broad, *Philosophy* 24, 291 (1949).
- J. B. Rhine, *New Frontiers of the Mind* (Farar and Rinehart, New York, 1937).
- R. Walker, *Sci. Monthly* 79, 1 (1954).
- Quoted in reference 3, p. 357.
- H. Reichenbach, *The Theory of Probability* (Univ. of California Press, Berkeley, 1949), p. 476.
- I refer here to genuine magic, not the deceptions of mediums and stage conjurers. Five methods of table levitation employed by mediums are disclosed by J. Dunninger in *Inside the Medium's Cabinet* (David Kemp, New York, 1935).
- I am using *magic* in a particular sense, defining it in terms of what can be explained in a certain way—without regard to how those who attempt to practice it actually do try to explain it. Actions that overtly resemble magic ceremonies and yet are based on mechanistic reasoning (like much of alchemy), I would call not magic but gropings toward science.
- J. L. Lowes, *The Road to Xanadu* (Houghton Mifflin, Boston, 1927).
- J. Hadamard, *The Psychology of Invention in the Mathematical Field* (Princeton Univ. Press, Princeton, N.J., 1945).
- W. Pitts and W. S. McCulloch, *Bull. Math. Biophys.* 9, 127 (1947).
- J. B. Rhine, *Extra-Sensory Perception* (Humphries, Boston, 1935).
- R. K. Nabours, *Philosophy of Science* 10, 191 (1943).
- B. F. Skinner, *Am. Scientist* 36, 456, 482 ff. (1948).
- D. H. Rawcliffe, *The Psychology of the Occult* (Ridgway, London, 1952). I think that most of Rawcliffe's ideas are correct, but that his explanation of Soal's work in terms of involuntary whispering is implausible.
- G. S. Brown, *Nature* 172, 154 (1953). I think that Brown's criticism has been adequately refuted by Soal in reference 3.
- H. Sidgwick, *Proc. Soc. Psychical Research* 1, 7 (1882).
- W. W. Carington, *ibid.* 46, 265 (1940).
- H. Houdini, *A Magician among the Spirits* (Harper, New York, 1924).
- F. Podmore, *Modern Spiritualism* (Methuen, London, 2 vols., 1902); *The New Spiritualism* (Holt, New York, 1911).
- J. C. R. MacDonald, *Crime Is a Business* (Stanford Univ. Press, Stanford, Calif., 1939).
- C. D. MacDougall, *Hoaxes* (Macmillan, New York, 1940).
- W. Crookes, *J. Soc. Psychical Research* 6, 341 (1894). Dissenting opinions concerning Home have been written by Podmore (32), Houdini, and R. Browning. Houdini (31, p. 49) states that "His active career, his various escapades, and the direct cause of his death all indicate that he lived the life of a hypocrite of the deepest dye." (Houdini does not name the cause of Home's death, although he does quote this sentence from Madame Blavatsky's *Key to Theosophy*: "This Calvin of Spiritualism suffered for years from a terrible spinal disease, brought on through his intercourse with the 'spirits,' and died a perfect wreck.") And Browning, in "Mr. Sludge, 'the Medium,'" gives this picture of Home: "Now, don't sir! Don't expose me! Just this once! This was the first and only time, I'll swear,—/Look at me,—see, I kneel,—the only time, I swear, I ever cheated,—yes, by the soul/Of Her who hears—(your sainted mother, sir!)/All, except this last accident, was truth—"
- S. G. Soal, *Proc. Soc. Psychical Research* 50, 67 (1953), especially pp. 84, 94.
- , *The Experimental Situation in Psychical Research* (Society for Psychical Research, London, 1947), pp. 25 f.
- G. E. Hutchinson, *Am. Scientist* 36, 291 (1948).
- C. D. Broad, *Philosophy* 19, 261 (1944).
- Paraphrased from a report by J. F. Rinn, published by J. Jastrow in *Collier's Weekly* 45, No. 8, 21 (14 May 1910).
- S. G. Soal, *Proc. Soc. Psychical Research* 40, 165 (1932); *J. Soc. Psychical Research* 30, 55 (1937); *Preliminary Studies of a Vaudville Telepathist* (Univ. of London Council for Psychical Investigation, London, Bull. III, 1937).
- , *Proc. Soc. Psychical Research* 46, 152 (1940).
- and K. M. Goldney, *ibid.* 47, 21 (1943).
- F. Bateman and S. G. Soal, *J. Soc. Psychical Research* 35, 257 (1950); S. G. Soal and F. Bateman, *J. Parapsychol.* 14, 168 (1950).
- Since there was a pause at the middle of each run, and pre- and postcognitive hits occurring across this gap were not scored, there were 48 "+1" trials per run of 50.
- This description of Soal's experiments omits details not relevant to my argument. For example, I have said nothing concerning precautions taken against tampering with the records. Therefore, readers previously unfamiliar with Soal's work should be cautious in deciding that they have found a flaw in it.
- Houdini states: "Regarding the possibility of using codes and cues before others without being detected I can say positively that it is not only possible but simple and practical" (reference 31, p. 259). And Soal in several different places discusses auditory codes and other signaling means: for example, in reference 3, pp. 104, 117.
- A variety of ways are available for setting up such a system. In one of these, 22 prepared guess sheets can suffice for a sitting of 8 runs, and simple, short-cut methods are available for quickly preparing the lists of guesses.
- Of the \$21,000, \$1000 was offered by *Science and Invention* magazine, \$10,000 by Dunninger, and \$10,000 by the same J. F. Rinn who observed Palladino's footwork at close range. Further details are given in reference 19, and in J. Dunninger, *Houdini's Spirit Exposed from Houdini's Own Manuscripts, Records and Photographs* (Experimenter Publ., New York, 1928). Of course, no medium ever won the \$21,000. No doubt, if any one of them had been clever enough to devise a trick that Dunninger could not duplicate, that person would not have been a medium, for he would probably have preferred to make an honest living as a conjurer.
- Strong hostility toward supernaturalism is desirable as a safeguard, even though it is not absolutely essential. To be sure, Houdini had strong yearning to find evidence for the supernatural, and yet he was a most effective exposé of psychic fraud, but such a combination is exceedingly rare.
- D. J. West, *J. Soc. Psychical Research* 37, 323 (1954).
- G. W. Fisk and D. J. West, *ibid.* 38, 1 (1955).
- G. L. Mangan, *J. Parapsychol.* 19, 35 (1955); H. Forwald, *ibid.* 19, 45 (1955).
- Soal (36), in replying to criticism by Rawcliffe (27), writes: "All Mr Rawcliffe's knowledge is derived from books; to the best of our belief he has never in his life published a single experiment in the field of parapsychology." Also, Soal writes (3, pp. 23 f.): "It would be interesting to meet the psychiatrist or psychologist who has perused every page of the 49 volumes of the *Proceedings of the Society for Psychical Research*, and who remains a complete sceptic." It would be interesting indeed.
- For reading early drafts of this paper and making numerous helpful suggestions, I am greatly indebted to Herbert Feigl, Bernard Gelbaum, Gerhard Kalisch, Leo Marx, Paul Mehl, and Michael Scriven, all of the University of Minnesota, and to Claude Shannon of Bell Telephone Laboratories. However, this must not be taken as implying that these men or the Department of Medicine, University of Minnesota, necessarily endorse my views.

A textbook must be exceptionally bad if it is not more intelligible than the majority of notes made by students. . . . The proper function of lectures is not to give a student all the information he needs, but to rouse his enthusiasm so that he will gather knowledge himself, perhaps under difficulties.—J. J. THOMSON.

News of Science

NSF Special Committee

A Special Committee on Medical Research has been named by the National Science Board to review and evaluate the medical research programs of the U.S. Department of Health, Education, and Welfare, according to a joint announcement made on 12 Aug. by Secretary of Health, Education, and Welfare Marion B. Folsom and Alan T. Waterman, director of the National Science Foundation. The review is being made at the request of the Department of Health, Education, and Welfare.

The special committee is headed by C. N. H. Long, chairman of the department of physiology, Yale University School of Medicine. Other members of the committee are E. A. Doisy, professor of biochemistry, St. Louis University School of Medicine; Ernest W. Goodpasture, Armed Forces Institute of Pathology, Walter Reed Army Medical Center; A. B. Hastings, department of biological chemistry, Harvard Medical School; Charles Huggins, director, Ben May Laboratory for Cancer Research, University of Chicago; Colin M. MacLeod, department of microbiology, New York University School of Medicine; C. Phillip Miller, department of medicine, University of Chicago; W. M. Stanley, director, Virus Laboratory, University of California. Joseph W. Pisani, on leave of absence from the State University of New York College of Medicine in Brooklyn, where he is assistant dean, is serving as executive secretary of the committee.

The department's request to NSF was made in a letter addressed to the director by former Secretary Oveta Culp Hobby earlier this year. She pointed out that the department's program comprises a major portion of the Federal activity in medical research and expressed the view that it should be subjected to critical review, particularly with regard to its scope and the distribution of support among the various special areas of medical research.

Specifically, the Secretary requested that the review of the department's program include the following: consideration of the rate of growth of the programs of the National Institutes of Health, other research units of the Public Health Service, and other units of the department in the light of the responsi-

bilities of the Federal Government with respect to health, medical, and related research; a general appraisal of the present level of support of medical research by the department; careful consideration of the proper balance of effort with respect to the support of basic research and research aimed more directly at the prevention, diagnosis, and cure of diseases; and the relative distribution of effort among the major special fields of health research.

The Department of Health, Education, and Welfare took cognizance of the foundation's survey of the national scientific research and development effort, including the medical research activities of universities, industry, and government. The department's request was for an interim appraisal of its medical research programs by a special committee appointed by the foundation, pending completion of the over-all survey.

The basis of the Secretary's request was NSF's statutory authority to evaluate scientific programs undertaken by agencies of the Federal Government. In accepting the responsibility for an interim study, Waterman pointed out that it would not be possible to relate the medical research program of the Department of Health, Education, and Welfare to the national effort in medical research in any complete sense until the findings of the foundation's over-all survey are complete. Nevertheless, he expressed a willingness to provide for a preliminary review and has asked the Special Committee on Medical Research to submit its findings to the National Science Board in time for the December 1955 meeting of the board.

Australian Plant Introduction

A number of countries, including Australia, have an active import and export business in the exchange of seeds and grasses and crop plants. Australia has a Plant Introduction Section in the Commonwealth Scientific and Industrial Research Organization that does a flourishing business in meeting requests by other countries for seeds of Australian plants and in arranging similar importations from abroad. Since the Plant Introduction Section was established in 1929, something like 20,000 items have been

imported into Australia for experimental purposes.

When the early settlers discovered that there was an almost complete absence of native plants suitable for crops, they arranged to bring out the seeds of English crop and garden plants and grasses. However, it soon became clear that there were vast areas of Australia where plants from England and from many parts of Europe could never be established.

The early introductions of cereal seeds and grasses formed the basis for the development of Australia's primary industries. Besides the cereals, the importation of such pasture species as subterranean clover, the rye grasses, phalaris, and others, have completely revolutionized grazing and agriculture. Many millions of acres are now seeded with these introduced grasses.

Today efforts are being particularly directed toward finding new plants for the tropical, subtropical, and semiarid areas of Australia, as well as toward searching for better strains of the pasture plants already established in southern Australia.

On arrival in Australia, overseas plants and seeds are given initial trials in the quarantine nurseries that have been established in most states and in the Northern Territory. During these trials an assessment of a plant's suitability is made, and supplies of the more promising seeds are built up for more extensive tests, which may include grazing by animals. This procedure takes a number of years and it may be some time before seed can be released with confidence for use on a commercial or semicommercial scale.

Decision on Cole Case

In a 2-to-1 decision handed down on 28 July, the U.S. Court of Appeals ruled against Kendrick M. Cole, a former food and drug inspector in the Department of Health, Education, and Welfare who was dismissed from his job in January 1954. Cole was removed on security grounds because of charges that he had associated with persons reported to be Communists and had made donations to, and attended meetings of, an organization designated as subversive by the Attorney General.

Cole's case was based on the premise that the Federal Employees Security Program does not apply to men in nonpolicy-making positions. He challenged the presidential authority to issue a security-risk order instructing all agency heads to make sure that retention of every worker is "consistent with national security."

The majority decision of Judge E. Barrett Prettyman and Judge Walter M. Bastian held that the basic law authoriz-

ing security firings makes no mention of sensitiveness and policy-making. The section of the Security Act that the majority cited as the key one reads:

"The provisions of this act shall apply to such other departments and agencies of the Government as the President may, from time to time, deem necessary in the best interests of national security."

Prettyman and Bastian felt that, in the light of this section, the President's 1953 executive order extending the security program to all Federal agencies was justified. It is this 1953 order that permits summary dismissal of any Federal worker for security reasons.

In his dissent, Chief Judge Henry W. Edgerton said of the President's order:

"I think this blanket extension [of the President's] is unauthorized and invalid. Congress had specified some agencies that have something to do with national security. Committee reports describe them as 'sensitive' or concerned with 'vital matters' affecting national security. . . .

"Evidently Congress thought some other agencies might likewise be concerned with national security. Accordingly, Congress authorized the President to extend the act. There is, I think, not the slightest reason for supposing that Congress intended to authorize the blanketing in of all agencies."

Edgerton also pointed out that Cole's agency head did not make a determination that the firing was "necessary or advisable in the interests of the national security," as is authorized by the security act. Cole's superior found only that his continued employment "is not clearly consistent with the interests of national security," a yardstick which Edgerton felt the President laid down in his executive order without authority. The dissenting opinion held that this concept of the President's "differs vitally from the 'necessary or advisable' test that Congress prescribed."

News Briefs

■ A group of experts from 13 countries, called together by United Nations Educational, Scientific and Cultural Organization, met 23-24 June at UNESCO headquarters in Paris to discuss problems raised by the rapidly increasing use of radioisotopes. Pierre Auger, director of the UNESCO department of natural sciences, was chairman of the conference, which made several recommendations. First, it asked that UNESCO study various national procedures for the safe transport of radioisotopes and draft a set of international regulations. Next, it asked that UNESCO collect and evaluate existing regulations for waste disposal and, in collaboration with qualified scientific consultants, suggest international stand-

ards. In connection with waste disposal, the group noted that the problem has not only dangerous implications but that it is also extremely difficult to deal with, partly because of the widespread lack of agreement among the experts themselves.

On the basis of UNESCO's experience in drawing up and obtaining the adoption by a number of countries of a system facilitating the rapid transit of delicate measuring instruments, the group urged that UNESCO undertake to establish a similar system for the rapid customs clearance of radioisotopes. The meeting participants held that such clearance is essential for the effective utilization of radioisotopes, especially those with a very short half-life. Finally, the experts asked that UNESCO collect and publish as soon as possible all available information on labelled molecules and recommend ways for closer international collaboration in the production and use of these tracers. It was pointed out that the synthesis of certain molecules is too great a burden for a number of less well-equipped countries.

Any international regulations drawn up by UNESCO as a result of these recommendations are to be circulated to the member states and to the specialized agencies concerned. A second meeting of the group will take place in Paris, 13-14 Oct. Howard A. Robinson, special assistant to the United States Ambassador to France, is this country's representative.

■ The Atomic Energy Commission has declassified all technical information on current extraction processes for recovering uranium from uranium-bearing materials to produce unrefined uranium concentrates. The declassification is expected to benefit the commission's program for developing more efficient methods of processing uranium ores by encouraging the participation of private enterprise. The declassification action does not include information relating to the refinement of uranium concentrates into highly purified forms, nor does it include technical information on any new and important extraction processes that may have been developed.

Unrefined uranium concentrates are produced in 12 processing plants in Colorado, Utah, New Mexico, Florida, and Illinois. Four additional plants are under construction. With one exception, all of the plants are privately owned and operated.

■ The pigment that tints the eyes of one species of euphausiid has recently been isolated by Elizabeth K. Boden, assistant research biologist at the University of California's Scripps Institution of Oceanography. This is the first time a photosensitive pigment has been extracted from the eyes of any of the arthropods.

Boden proposes the name *euphausiopsin* for the new pigment.

Euphausiopsin was found to be linked with vitamin A₁, already known to be present in particularly high concentrations in the eyes of euphausiids. A₁ is the vitamin in the eyes of human beings that makes it possible to see in near darkness.

Tests have indicated that the euphausiopsin may be especially sensitive to blue-green light. The euphausiid swims up and down in the ocean in apparent response to the intensity of sunlight, always being found at a level where the light maintains a constant dim value. Often these creatures form part of a deep scattering layer.

Boden has described her discovery in a paper that appeared in a recent issue of *Nature*. Her work has received support from the Office of Naval Research.

■ A new disease, pancreatic necrosis, is killing up to 80 percent of the young brook trout in three West Virginia hatcheries, placing the state's hatchery program in danger. The disease, unknown until last year, affects fingerling trout, causing them to whirl violently.

The malady appeared first at the Leetown, W. Va., Fish and Wildlife Service Station in January 1954; by July 1954, it had spread to hatcheries at Dorcas and Marlinton. S. F. Snieszko of the Leetown Microbiological Laboratory, Kearneysville, and his colleagues E. M. Wood and W. T. Yasutake, reported the disease in the July *Archives of Pathology*.

■ A new signaling system for telephone dialing, a polytonic coder, has been developed by C. A. Lovell, J. H. McGuigan, and O. J. Murphy of Bell Telephone Laboratories, New York. A test model of the signaler can send 100 digits a second reliably over almost all telephone connections. The device may eventually make it possible to discard telephone dialing.

The term *polytonic* was coined because the system uses five separate frequencies; each digit is represented by a different two-tone combination.

Scientists in the News

IMMANUEL ESTERMANN, deputy science director for coordination and director of the material sciences division of the Office of Naval Research, Washington, D.C., has received the 1955 Pittsburgh physics award. He was honored for his contributions to fundamental physics while he was a professor at Carnegie Institute of Technology. With assistance from ONR and from the Research Corp., he organized and developed the low-temperature laboratory at C.I.T.

M. S. THACKER, director of the Indian Institute of Science, Bangalore, was appointed director of the Council of Scientific and Industrial Research in New Delhi, effective 3 Aug. In the Republic Day honors last January, Thacker was the recipient of the *Padma Bhushan*, an award for outstanding achievement that is presented by the Government of India.

FRANK W. PUTNAM, formerly a staff member of the Argonne Cancer Research Hospital in Chicago, Ill., has been named to head the department of physiological chemistry of the University of Florida College of Medicine, effective 1 Sept.

The Lebanese Republic awarded a citation and a medal of Knight of the Order of Cedars to HOBART A. REIMANN for medical services to the people of Lebanon during his tenure as visiting professor of medicine at the American University of Beirut.

CHARLES E. LAPPLE, former associate professor of chemical engineering at Ohio State University, and RUDOLF H. THIELEMAN, former development metallurgist for the Pratt and Whitney Aircraft Corp., have joined the chemical and metallurgical engineering section of Stanford Research Institute's physical sciences division. Lapple, as a senior scientist, will organize, coordinate, and direct research activities in the fields of fine-particle technology and chemical engineering. He is a specialist in dust and fume collection, abatement of atmospheric pollution, particle sizing, and the handling of fluids.

Thielemann, who has been appointed senior metallurgical engineer, is a specialist in high-temperature alloys, stress, titanium, and nuclear reactor metallurgy.

WILL E. EDINGTON, former head and now emeritus professor of mathematics and astronomy at DePauw University, has been appointed to the Margaret Pilcher professorship of mathematics at Coe College, Cedar Rapids, Ia., for 1955-56.

F. J. ALLEN of the Purdue University chemistry department has been granted leave for the coming academic year. He will devote part of his time to visiting chemical industries and chemistry departments in colleges and universities throughout the country and part to study at California Institute of Technology and at Oregon State College.

GEORGE C. WEBSTER, former senior research associate in the division of biology, California Institute of Technology, has been appointed associate professor of agricultural biochemistry at Ohio State University.

ELWOOD A. SHARP, authority on blood diseases and director of clinical investigation for Parke, Davis and Co. since 1929, has been promoted to medical assistant to the firm's president, Harry J. Loynd. ELMORE C. VONDER HEIDE, who became associate director of the Clinical Investigation Department in 1937, will succeed Sharp. The department medically evaluates new drugs by means of field tests that are carried out all over the world.

ARTHUR GEORGE ZUPKO, formerly a professor at the St. Louis College of Pharmacy and Allied Sciences, has been appointed associate dean of the Brooklyn College of Pharmacy, Long Island University.

HENRY T. NAGAMATSU, an authority on hypersonic flow problems and for the past 6 years director of hypersonic wind-tunnel research at California Institute of Technology, has been named to the staff of the General Electric Research Laboratory in Schenectady, N.Y. He will conduct hypersonics research in the mechanical investigations section of the chemistry research department.

GEORGE A. AGOSTON, former senior research engineer with California Institute of Technology, has joined the physical sciences division of Stanford Research Institute as a senior physicist. He will conduct research on combustion and fluid dynamics.

BRIAN MACMAHON, lecturer in social medicine at the University of Birmingham, England, has been appointed associate professor of environmental medicine and community health at the State University of New York College of Medicine in Brooklyn. Much of MacMahon's research has involved the study of environmental influences as a cause of congenital defect, notably pyloric stenosis, congenital heart disease, and malformations of the nervous system.

BERTHA A. KLIEN, who previously has been in private practice in Chicago, Ill., has been appointed associate professor of ophthalmology in the University of Chicago department of surgery.

MARSHALL C. HARRINGTON, head of the physics department at Drew University, has resigned to accept a research post with the U.S. Navy at its David Taylor Model Basin in Carderock, Md. He has been assigned to the basin's hydromechanics laboratory, where he will work in the viscous flow section of the fluid dynamics branch. His research activities will be chiefly in theoretical physics, a subject in which he will also teach a course at the University of Maryland.

HERBERT RATTNER, professor and chairman of the department of dermatology at Northwestern University, has been appointed editor-in-chief of the *American Medical Association Archives of Dermatology*.

The Acoustical Society of America has awarded its 1955 gold medal to FLOYD A. FIRESTONE of Dobbs Ferry, N.Y., "in appreciation of his outstanding contribution to the society and to the science of acoustics." A past president of the society, Firestone devised the mobility analogy and invented the ultrasonic reflectoscope.

J. E. CUMMINS has just taken up the duties of scientific attaché for Australia at the Australian Scientific Liaison Office, in Washington, D.C. Previously, for a period of 6 years, he served as chief scientific liaison officer in London. His particular interests are in forest products and in certain aspects of scientific documentation. Cummins succeeds E. J. DRAKE, who has returned to Australia.

CHARLES H. EADES, JR., assistant professor of chemistry at the University of Tennessee Medical Units since 1948, has resigned to join the staff of Meade Johnson Research Laboratories at Evansville, Ind.

The following are among those who have received honorary doctoral degrees this year.

Amherst College: W. MONTAGUE COBB, chairman of the department of anatomy at Howard University Medical School, and a vice president of the AAAS and chairman of its Section H—Anthropology.

Harvard University: GEORGE B. KISTIAKOWSKY, professor of chemistry at Harvard University.

Missouri School of Mines and Metallurgy: F. STILLMAN ELFRID, executive vice president of Olin Mathieson Chemical Corp.

Michigan College of Mining and Technology: MELVIN C. CALVIN, professor of chemistry at the University of California, Berkeley.

Case Institute of Technology: KENT R. VAN HORN, director of research, Aluminum Co. of America.

University of South Dakota: MAURICE NELLES, director of research and diversification, Technicolor Motion Picture Corp.

Necrology

FRANK BERNER, New York, 60, psychoanalytic specialist, former associate at the College of Physicians and Surgeons, 4 Aug.

HENRY E. BLISS, Plainfield, N.J., 85, retired assistant librarian of the City College of New York, developer of a new system of bibliographic classification, author, 9 Aug.

DOROTHY L. BOOK, Boston, Mass., 52, dean of the Boston College School of Social Work, 9 Aug.

FRANK J. BRUNO, Lebanon, Ind., 81, former head of the sociology department of Washington University in St. Louis, 7 Aug.

WILLIAM L. CARLYLE, Calgary, Alberta, Canada, 85, former professor of animal husbandry at the University of Wisconsin, dean of agriculture at Colorado Agricultural and Mechanical College, dean of agriculture at the University of Idaho and director of the United States experimental station in Idaho, acting president of the University of Idaho, and dean of agriculture at Oklahoma Agricultural and Mechanical College, 6 Aug.

JOEL E. DEUTERMAN, Elgin, Ill., 53, cancer research specialist, 7 Aug.

WILLIAM J. HALE, Midland, Mich., 79, retired director of the organic research laboratory of the Dow Chemical Co., author, 8 Aug.

ABRAHAM LIGHTSTONE, New York, 80, surgeon, formerly on the faculties of the New York University and Fordham University medical schools, 6 Aug.

GEORGE W. LUCAS, Detroit, Mich., 46, supervisor of carbide materials and process engineering, Carbonyl Department of General Electric Co., 28 July.

FREDERICK PEARSON, Williams Bay, Wis., 68, retired head lens grinder at Yerkes Observatory, authority on astronomical optics, 8 Aug.

Education

■ An article in the July issue of the *Plant Science Bulletin* describes one of the difficulties encountered by those seeking university appointments. It is entitled "The responsibilities contingent upon the solicitation of applications," and it is accompanied by an editor's note that says: "This brief paper, submitted by two former graduate students who have recently received their Ph.D. degrees from large state universities . . . and who wish to remain anonymous, presents a viewpoint which might have a message for some academic administrators."

Several abstracts from the article follow:

"One of the anomalies of etiquette is that it is quite improper to call a person's breach of the rules of decorum to his attention. Even if this were not so, however, no [job] applicant in his right mind would dare endanger his position by writing anything but the most discreet note asking whether his application had been received and, possibly, whether or

not it was being considered. . . . The proper acknowledgment of receipt of all applications and supporting papers is the least an administrator can do for the people who have submitted applications, whether they were solicited directly or not. . . .

"Several of us have compared our application correspondence over the past few years and find that . . . [the] 'solicit and forget' attitude is not limited by university size or geographic location. North, east, south or west, the story is commonly the same. . . . The time schedule would often do justice to a sleepy snail. One . . . simple inquiry about an application was made on November 24. The answer was received (via airmail) the following February 12!

"If such treatment is intentional, perhaps as a form of academic natural selection in which only the most stubborn stay in the race, there may be some merit to the procedure. If, on the other hand, this is not the idea behind such treatment we should imagine that . . . chairmen the country over are becoming afraid to look a stranger in the eye—it might be that applicant they just never bothered to write. In any event the actions of some administrators on this score certainly cannot be said to be beneficial to our science. Aside from the low salaries, the very least that a prospective colleague should expect from the profession he has chosen is a moderate amount of consideration at a relatively critical point in his career."

■ On 12 Aug. 24 secondary-school teachers of science and mathematics from Alabama, Georgia, Mississippi, and North Carolina received certificates for the successful completion of the first session of an 8-week intensive summer program at Howard University that is supported by the Phelps-Stokes Fund of New York. Each of these teachers was enrolled in astronomy, geology, and science education courses. In addition, each studied two of these four subjects: biology, chemistry, mathematics, and physics.

All courses were especially designed for secondary-school teachers. The group visited government laboratories and museums, and there were four Saturday field trips. The grant of \$50,000 by the Phelps-Stokes Fund to Howard will permit repetition of the program during the summers of 1956 and 1957.

■ The University of Pennsylvania has announced that it will prepare a group of civilian scientists to serve as Air Force operations analysts in event of a major national emergency. Under Air Force contract, the Institute for Cooperative Research at the university will form an "operations analysis stand-by unit" of some 10 to 20 men, drawn mainly from

its own faculties, according to Carl C. Chambers, the university's vice president for engineering affairs and acting director of the institute.

J. Parker Bursk, chairman of the department of economic and social statistics in the university's Wharton School of Finance and Commerce, will be project director. Unit members will include mathematicians, statisticians, engineers, and specialists in the various physical and social sciences. They will devote an average of 40 days annually to indoctrination in operations analysis and Air Force procedures.

Grants, Fellowships, and Awards

■ The Arctic Institute of North America is offering research grants in 1956 for scientific investigations dealing with the arctic and subarctic regions. Priority will be given to field investigations in North America or to studies at one of the institute's offices.

Applications for research grants are invited from those who have demonstrated their ability to conduct research work of superior quality in some field of science. Proposals in the broad field of the earth sciences, in marine biology, and in physiology are especially desired. Facilities of the Arctic Research Laboratory at Barrow, Alaska, are available for a limited number of scientists for both summer and winter investigations. The facilities include both housing and equipment.

Application forms may be obtained upon request from: Arctic Institute of North America, 1530 P St., N.W., Washington 5, D.C. Completed applications should be received before 1 Nov. 1955. Late applications will be considered in special circumstances if additional research funds become available.

The Arctic Institute is also in a position to award grants from a sum of money provided by the trustees of the Banting Fund, which is used primarily to encourage Canadians, particularly recent graduates, in northern studies. Inquiries should be addressed to: T. H. Manning, 37 Linden Terrace, Ottawa 1, Ont., Canada.

■ The American Cancer Society is offering a limited number of clinical fellowships to provide graduates in medicine opportunities for postgraduate training that emphasizes diagnosis and treatment of cancer. Fellowships available on and after 1 July 1956 will be awarded for 1 year and are renewable for 2 additional years.

These \$3600 awards are made to institutions only upon application by deans, executive officers, or department heads. Therefore, individuals desiring this ACS

support should consult the appropriate authority in the institution of their choice.

Applications for 1956-57 fellowships must be submitted by 15 Sept. Further information may be obtained from the Professional Educational Section, American Cancer Society, 521 W. 57 St., New York 19.

■ The Ford family has announced that it is establishing a \$1-million fund to reward scientists who develop peaceful uses of atomic energy. Henry Ford, II, president of Ford Motor Co., and his brothers, Benson and William, will contribute the \$1-million total during the next 10 years from the Ford Motor Company Fund. The money will be administered by a nonprofit corporation to be known as Atoms for Peace Awards, a corporation that is to serve as a memorial to the brothers' grandfather and father, Henry and Edsel Ford.

The outline for the award proposes the creation of "a competent international jury of awards" to select the individual or group who has made the greatest contribution each year toward developing peaceful applications of atomic energy. Winning natural scientists, inventors, or engineers will be chosen "without regard for nationality or political belief."

The annual prize will consist of \$75,000 in cash and a "suitable medal to be designed and cast for the purpose." If no recipients can be found in any year, the money will go for scholarships and fellowships in peaceful atomic science.

In the Laboratories

■ Goodrich-Gulf Chemicals, Inc., Cleveland, Ohio, will build manufacturing facilities to produce its new synthetic rubber. A pilot plant will be located in northern Ohio and is expected to be in operation within 9 months to 1 year. When these facilities are completed, materials for testing will be available to other companies.

Announcement that Goodrich-Gulf scientists, working in the B. F. Goodrich Research Center, Brecksville, Ohio, had succeeded in reproducing the true molecule of crude rubber was made in Dec. 1954.

■ A comprehensive program of nuclear research, aimed at investigation of new energy sources and improvement of petroleum refining and petroleum products, has been undertaken by Socony Mobil Oil Co., Inc., New York. The program encompasses:

1) Participation by Socony Mobil in a joint effort by eight American business enterprises in construction of the first nuclear reactor to be owned and oper-

ated by private industry for research in industrial and humanitarian fields.

2) Establishment of a Nuclear Research Center wholly owned and operated by Socony Mobil Research Laboratories and including: (i) Van de Graaff accelerator and associated facilities providing high-energy electrons, protons, x-rays, and neutrons for research in nuclear physics and radiation chemistry; (ii) "hot" laboratories equipped for manipulation of fission-waste radioisotopes as well as secondary radioactive sources, such as antimony-124, cobalt-60, and iron-59, which will be activated by irradiation in the nuclear reactor; and (iii) a "counting" laboratory for assaying radioactive materials, general research laboratories, offices, and facilities for health protection of staff members.

Construction of both major facilities—the reactor and the Nuclear Research Center—is expected to begin in early fall, and plans call for the start of operations within a year. Exact geographic location of the two facilities has not yet been finally determined.

■ The board of directors of Nuclear Development Associates, Inc., White Plains, N.Y., has announced a change in the name of the organization to Nuclear Development Corporation of America. The change was effective on 1 Aug. The firm is developing a 1200-acre tract near Pawling in Dutchess County, New York, to serve as a nuclear experimental station.

■ A joint program of applied research to advance supersonic aircraft and missile propulsion has been established by Marquardt Aircraft Co., Van Nuys, Calif.; Reaction Motors, Inc., Denville, N.J.; and Olin Mathieson Chemical Corp., New York. The new coordinated technical effort of complementary skills, known internally as the OMAR program, combines the research, engineering, and production resources of the three organizations.

Administration of the OMAR program is under the direction of a technical liaison committee comprised of representatives of the participating companies. Members of the committee are Harry A. Sosnoski, Olin Mathieson, chairman; T. F. Walkowicz, of the staff of Laurance Rockefeller, vice chairman (L. Rockefeller is a stockholder in both Marquardt and Reaction); John A. Drake, Marquardt Aircraft; William P. Munger and Warren P. Turner, Reaction Motors; and L. Kermit Herndon, Joseph H. McLain, and John J. O'Neill, Jr., Olin Mathieson.

The research and development program embraces rocket and ramjet engine design, rocket and ramjet engine propellants, and special mechanical and chemical engineering processes. It is directed

toward advancing basic propulsion science and providing improved methods for the production of rocket and ramjet engines, their propellants, and related devices.

Miscellaneous

■ The Army has received authority from the Civil Service Commission to employ civilian physicians at dispensaries, infirmaries, outpatient clinics, and laboratories at the top step of each respective CSC grade. For example, effective immediately, civilian physicians may receive beginning salaries of from \$7465 to \$11,395 per annum.

Although increasing numbers of civilian doctors are joining Army medical installations throughout the country, openings exist in practically every locality. On 30 June, the Army was employing more than 20 percent more civilian physicians than it was 6 months earlier. Those interested in securing employment with the Army, and who have a license to practice medicine in any of the states or the District of Columbia, should communicate with the personnel officer at the nearest Army installation of their choice.

■ The International Film Bureau Inc., 57 E. Jackson Blvd., Chicago 4, Ill., has published a descriptive list entitled "16mm films in health, education and welfare." The large majority of the films listed deal with human relations and are classified under such headings as mental health, psychology, child study, education, community action, teaching aids, education of the retarded, medical sciences, nursing, and safety and welfare. The psychology films available are arranged in four groups: general, comparative, child psychology, and child care.

■ A 374-page bibliography on infrared radiation and its multitude of applications in science, technology, and industry has been made available to the public by the Office of Technical Services, U.S. Department of Commerce. Compiled by the Library of Congress under a contract from the Office of Naval Research, the bibliography includes all references to published literature on the subject from 1935 to 1951.

The classification proceeds from infrared theory and general infrared-optical properties through the various elements and components of infrared equipment, infrared spectroscopy and photography, to its various applications in science, technology, the arts and industry. *Infrared: A Library of Congress Bibliography*, (PB 111643) may be ordered from OTS, U.S. Department of Commerce, Washington 25, D.C., price \$3.

Reports and Letters

Neglected Aspects of Electroosmosis in Porous Bodies

Consideration of the process of electroosmosis reveals that conventional descriptions (1) of this phenomenon do not mention interesting and important features of electroosmotic flow in porous bodies.

Figure 1 shows a schematic representation of a plug of porous material (such as unglazed porcelain) that separates two compartments containing electrodes. Let us assume that these compartments contain a solution that is in equilibrium with the solution that fills the pores of the plug, and let us also assume that the electrode compartments are flushed with fresh solution at such a rate that, when voltage is applied to the electrodes, the products of electrolysis are swept out and the composition of the solution in the compartments remains practically unchanged.

At liquid-solid interfaces, such as are present inside the plug, segregation of electric charges commonly occurs, forming an electric double layer. When a gradient of electric potential is imposed on such a system, the segregation of charge results in electroosmosis in which the pore water moves, in relation to the plug, in the direction of the electrode that has the same polarity as the charge residing in the surface of the solid phase.

When the plug is immobile and its charge is equally immobile, conduction of electricity within the plug depends on (i) motion of the counter-ions toward the appropriate electrode, and (ii) motion, toward the opposite electrode, of the "co-ions" (that is, ions carrying charges of the same sign as the surface). In comparison with the solution in the electrode chambers, the conduction of electricity in the plug involves a greater transport of charge by counter-ions and a lesser transport by co-ions ("surface conduction"). This is consistent with the fact that the mobile charge present as counter-ions exceeds the mobile charge present as co-ions by the amount of immobile charge on the plug, whereas the mobile charges present as counter-ions and co-ions are equal in the electrode compartments.

According to Bloksma (2) the mobility of counter-ions in the plug is impaired by interaction with the plug charge; nev-

ertheless, since the mobility of the plug charge itself is very small or zero, the transport number for the counter-ions in the pore water will always exceed the transport number for the same species in the electrode compartments. In addition, the electroosmotic flow (by forcing the co-ions to migrate upstream while the counter-ions move downstream) increases the transport number of the counter-ions.

It follows from the differences that exist in the mode of conduction of electricity in the pore water and in the electrode compartments that electrolytes will tend to accumulate at the outflow face of the plug and disappear at the inflow face.

This conclusion is readily apparent in Fig. 1. For this example it is assumed that all the counter-ions (black) are of a single species, all the co-ions (white) are also of a single species, and the two species have equal valence and equal mobilities in the electrode compartments. The lines AA' , BB' , and CC' designate the locations of imaginary planes that intersect the electrode compartments and the porous plug. Suppose that a potential difference is applied to the two electrodes and that, in unit time, 4 electrons are collected by the anode and 4 electrons are released by the cathode. In order to sustain this process at a constant rate, there must be a net transport on 4 valence electrons in unit time across each of the three planes designated. At the planes AA' and CC' , this requirement will be met by the movement of 2 counter-ions and 2 co-ions that cross the planes in opposite directions. It has already been shown that, in the plug, the conduction of electricity involves a greater movement of counter-ions than of co-ions. This is represented in Fig. 1 by 3 monovalent counter-ions crossing the plane BB' in unit time, while only 1 monovalent co-ion crosses in the opposite direction, maintaining the requirement of a net transport of 4 valence electrons.

Since the events at the three planes designated are representative of events at all similar planes in the three parts of the system, discontinuities must occur at the inflow and outflow faces of the plug. It can be seen by inspection that, at the outflow face, one more counter-ion and one more co-ion will arrive in unit time than will depart, and salt will accumu-

late at that face. Inspection also reveals that salt will simultaneously be depleted at the inflow face. Thus, a concentration peak will develop at the outflow face and a concentration trough at the inflow face.

This accumulation-depletion process has an interesting consequence with respect to the stresses in the pore water during electroosmosis. Since the accumulation of electrolyte at the outflow face depresses the zeta potential and, by increasing the conductivity, lowers the gradient of the applied potential, the tendency for electroosmotic flow diminishes in the vicinity of the outflow face. The opposite is true at the inflow face.

If the plug is saturated with water, the total water flux must be constant along the length of the plug, in spite of differences in the tendency for electroosmotic flow. As a result, stresses must appear in the pore water in the plug. Under the circumstances of this example, the pressure in the pore water will everywhere exceed the pressure at the same level in the electrode compartments and the gradient of pressure must be directed outwards at each face. One would anticipate that a pressure maximum would occur in the plug in the vicinity of the inflow face for the following reasons:

- The zone of electrolyte accumulation is constantly being displaced outward at the discharge face by the migration of the pore water, while the zone of depletion tends to spread into the plug from the inflow face for the same reason.
- An increment of electrolyte depletion will have a larger effect on the conductivity (and, hence, on the gradient of the applied potential) than a similar increment of accumulation. Both of these effects do more to favor electroosmotic flow at the inflow face than to discourage it at the outflow face. This in turn causes

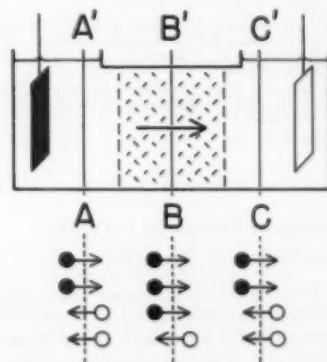


Fig. 1. (Top) Porous plug separating two electrode compartments. Electroosmotic flow is from left to right. (Bottom) Conduction of electricity by counter-ions (black) and co-ions (white) across planes AA' , BB' , and CC' .

a pressure maximum to occur within the zone in which depletion has occurred.

Between the inflow face and the pressure maximum a hydraulic countercurrent moves toward the inflow face along the central portion of the pores, while the electroosmotic flow occurs at the periphery. Between the outflow face and the pressure maximum, hydraulic flow and electroosmotic flow are in the same direction. In both cases the net flow is the same.

If the plug lacks homogeneity or if the solution in the electrode compartments is not one that would be in equilibrium with the original pore water, or if other conditions are altered, a variety of stress conditions may be induced in the pore water, including pore-water tensions (3). The point to be made at this time is that, even when the electrode compartments are flushed with a solution that is nominally in equilibrium with the pore water, initiation of electroosmotic flow induces processes that destroy the initial homogeneity of the pore water, distorting the applied electric field, altering the zeta potential, and confounding hydraulic and electroosmotic flow. The system is simply defined only at zero time, and measurements should be interpreted on this basis.

Zeta potentials computed by conventional methods from measurements of electroosmosis may be in error if it is assumed that the composition and pressure of the pore water remains unaffected by the process.

A more detailed analysis of electroosmotic flow in clay soils, together with pertinent experimental data, is in preparation (4).

R. D. MILLER

Department of Agronomy,
Cornell University, Ithaca, New York

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9 May 1955

Serotonin Release as a Possible Mechanism of Reserpine Action

Previous communications have reported certain similarities in the physiologic actions of reserpine, a tranquilizing agent, and serotonin (5-hydroxytryptamine), a substance postulated to have a role in brain function (1). Both compounds show sedative effects in mice and potentiate the action of certain hypnotics by a central mechanism (2). The poten-

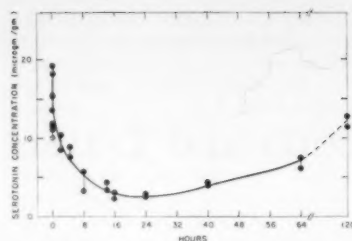


Fig. 1. Serotonin concentration in small intestine at various times after administration of reserpine. The points at zero time denote serotonin concentration in controls. The other points denote the serotonin concentration after administration of reserpine (5 mg/kg) to rabbits intraperitoneally (100 mg of reserpine was dissolved in a few drops of glacial acetic acid and diluted with 4 ml of propylene glycol, 4 ml of ethanol, and 8 ml of water).

tiation caused by either substance is antagonized by pretreatment with lysergic acid diethylamide (3), a compound that blocks the effects of serotonin on smooth muscles (4) and produces psychotic states in man (5).

It was also demonstrated that administration of relatively large doses of reserpine to dogs markedly increases the urinary excretion of 5-hydroxy-indoleacetic acid (3), a major metabolite of serotonin (6). These observations suggested that certain actions of reserpine are mediated through liberation of serotonin (3). The present communication describes experiments that show by direct analysis that reserpine effects the release of serotonin from the intestine, a major depot of serotonin in the body.

Rabbits received 5 mg/kg of reserpine intraperitoneally. Untreated rabbits served as controls. At various times after drug administration, animals were killed and 10 g of small intestine adjoining the stomach was removed, cut open, and washed with isotonic saline. The tissue was homogenized in 2 vol of 0.2N HCl, and the serotonin in the homogenate was measured by modification of the method of Udenfriend *et al.* (7). This method involves extraction of the serotonin into butanol, reextraction into dilute acid, and the formation of a colored derivative by reaction with α -nitroso- β -naphthol and nitrous acid. Application of the method to intestinal tissue disclosed the presence of a small amount of interfering material that also reacted with the nitrosonaphthol reagent. The interfering color was removed by shaking the solution of colored products with butanol.

Serotonin content of the small intestine declined progressively for about 16 hr after reserpine administration, finally reaching a concentration 15 to 20 percent of that of the average normal value (Fig. 1). The concentration of serotonin

remained at this low level for about 16 hr and then increased slowly, reaching the normal value after about 5 days.

The apparent serotonin in the tissue appeared to be identical with authentic serotonin as shown by comparison of fluorescence spectra (3N HCl) using a spectrophotofluorometer previously described (8), and by comparison of the absorption spectra of the nitrosonaphthol reaction products. In addition, on chromatographing the intestinal extract on paper (*n*-butanol-1N ammonia), the major amount of material fluorescing in acid and forming a blue color with *p*-dimethylaminobenzaldehyde showed the same R_f value as serotonin.

The effect of various doses of reserpine on the content of serotonin in small intestine was determined. As the dose was reduced, the decline in serotonin became gradually smaller but seemed evident with as little as 0.25 mg/kg of reserpine (Fig. 2).

The serotonin content of the whole intestinal tract was determined following the administration of reserpine. In three untreated rabbits, weighing about 2 kg each, the intestines contained an average of approximately 1000 μ g of serotonin. Sixteen hours after the administration of 5 mg/kg of reserpine, the content of serotonin in the intestines of three animals averaged 350 μ g. Thus the reserpine had caused the liberation of about 650 μ g of serotonin from this tissue.

A number of rabbits, especially those given the larger doses of reserpine, had diarrhea. Consequently, the effect of laxatives in purgative dosage (castor oil and magnesium sulfate) and of a cholinergic agent (prostigmine 0.3 mg/kg in three divided doses) was determined. These substances did not change the serotonin content of the intestine. Sedation *per se* did not effect serotonin release, since heavy barbital and phenobarbital narcosis for 12 hr failed to lower the serotonin content of the intestines.

Experiments described in this paper

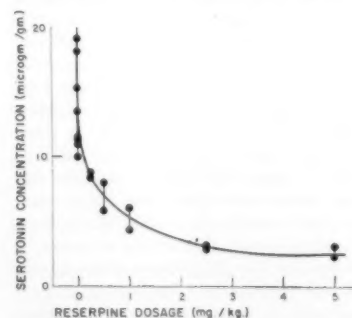


Fig. 2. Serotonin concentration in small intestine 16 hr after administration of various doses of reserpine.

are compatible with the view that some of the central effects of reserpine are mediated through the release of serotonin. It is conceivable that the beneficial effects of reserpine in mental disturbances result from the liberation of serotonin. The possibility that reserpine also affects the level of serotonin in brain is now under investigation.

ALFRED PLETSCHER*
PARKHURST A. SHORE

BERNARD B. BRODIE

Laboratory of Chemical Pharmacology,
National Heart Institute, National
Institutes of Health, U.S. Public
Health Service, Bethesda, Maryland

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* Guest worker from Hoffmann-La Roche, Basel, Switzerland.

25 May 1955

Burger Triangle as a Method for Correcting Inaccuracies of Einthoven Triangle

The triangle of Burger and van Milaan (1) was constructed on the basis of the lead vector concept. Burger and van Milaan demonstrated that, in contrast with the triangle of Einthoven, their triangle is accurate for calculating cardiac vectorial directions in the frontal plane of a human phantom, regardless of thorax form, tissue nonhomogeneity, and eccentricity of the assumed resultant heart vector. The shape of the Burger triangle is determined by these factors; the three sides are usually unequal (though the influence of the dispersion of the electromotive forces of the heart is not considered in their concept). To use such a triangle it is necessary, before beginning the usual procedure, to divide the deflections written in the classic limb leads by the length of the corresponding sides. Subsequent studies (2-8) suggest that the Burger triangle may prove to be more valuable in clinical electrocardiography than the Einthoven triangle.

The present communication demonstrates the relationship between the shape of the Burger triangle and the inaccuracy of the Einthoven triangle in the calculation of the vectorial directions in the frontal plane. A Burger triangle from a

given subject (human or animal, living or dead, or electrolytic model) could have one of three shapes: equilateral, isosceles, or scalene. If it is equilateral, which is exceptional, the Einthoven triangle is obviously accurate. If it is not equilateral, the Einthoven triangle is inaccurate. But isosceles or scalene triangles can have various accentuations and departures from the equilateral triangle.

Figure 1 shows four hypothetical Burger triangles from four subjects; a and b are isosceles, whereas c and d are scalene. But b and d depart more from the equilateral than do a and c . For convenience, a Burger triangle may be transformed to a triaxial reference system (just as the Einthoven triangle has been transformed to the triaxial reference system of Bayley) with parallel transposition of the three sides of the Burger triangle toward its geometric center until they coincide. In the same figure four triaxial reference systems—transformed from Burger triangles a , b , c , and d , respectively—are shown.

We may designate l , m , and n as the lengths of the lead vectors RL , RF , and LF of a Burger triangle; and p_1 , p_2 , and p_3 as projections of the heart vector upon l , m , and n . On the basis of the concept that the deflection of an electrocardiographic lead equals the scalar product of heart vector and the lead vector, one gets

$$L_I = l p_1, L_{II} = m p_2; L_{III} = n p_3$$

In order to demonstrate the relationship between the Burger triangular shapes in Fig. 1 and the inaccuracy of the Einthoven triangle, it is necessary to assume the heart vector to be of equal length in the same arbitrary direction, V ($+45^\circ$), in each case. From the terminus of V in each triaxial reference system, perpendicular lines to three sides were drawn; p_1 , p_2 , and p_3 were measured. From the equations, the deflections in L_I , L_{II} , and L_{III} were calculated. The values were used to plot the vectorial direction for each subject in the triaxial

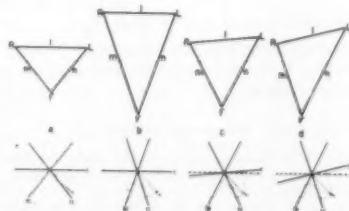


Fig. 1. Four hypothetical Burger triangles and corresponding triaxial reference systems. V is the arbitrarily true heart vector, which is assumed to be the same in each case.

reference system of Bayley (Fig. 2). The directions a , b , c , and d correspond to subjects with Burger triangles a , b , c , and d , respectively. It may be observed that they deviate from V (the arbitrary "true" direction); that $\angle boV$ is larger than $\angle aoV$, and that $\angle doV$ is larger than $\angle coV$.

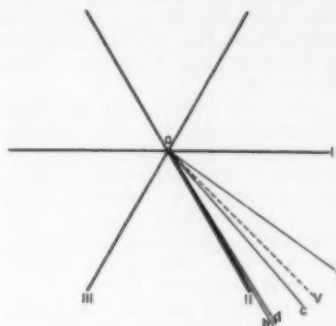


Fig. 2. The triaxial reference system of Bayley showing the directions of V and the calculated vectors.

The Einthoven triangle is inaccurate for subjects possessing Burger triangles either of isosceles or scalene shape. The more the triangle departs from the equilateral, the more the vectorial direction, calculated in the Einthoven triangle, deviates from the true one. Use of the Burger triangle permits correction of these potential errors.

ZANG Z. ZAO

Ribeirão Preto Medical School,
University of São Paulo, Brazil

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14 April 1955

Photochemical Activity of Chloroplasts Isolated from Sugar Beet Infected with Virus Yellows

Sugar beet virus yellows is a serious disease in Europe, where even the mild forms can reduce sugar yields by more than 20 percent (1). The disease now appears to be widespread in the western United States. Watson and Watson (2)

showed that the disease decreased the net assimilation rate of the plant and suggested, as one interpretation, that photosynthesis was slowed. Our experiments show that the disease interferes with the photochemical activity of the chloroplasts. This could decrease the amount of photosynthate available, which could well result in a decreased sugar yield. The effects of pathological conditions on the metabolic properties of chloroplasts have apparently not been investigated.

Kausche and Ruska (3), and Black, Morgan, and Wyckoff (4) published electron micrographs that indicated the presence of tobacco mosaic virus within the chloroplasts of infected tobacco plants. More recently Leyon (5) published electron micrographs of preparations from leaves infected with beet yellows virus that showed filamentous particles associated with the chloroplasts. Leyon suggested that the filaments represent the virus and that at least some of the virus was formed within the chloroplasts, although Nixon and Watson (6) argued that these filaments represent only a small part of the anomalous material in infected plants.

These experiments (7) were carried out with chloroplast fragments from leaves (8) of control and virus-yellows inoculated sugar beet plants (var. U.S. 75). Chloroplast fragments were prepared and stored as previously described (9). Chloroplast activity was measured

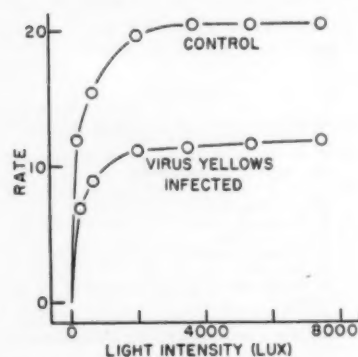


Fig. 1. Curves showing the effect of light intensity on the photochemical activity of chloroplast fragments isolated from control and virus-yellows-infected sugar beet leaves. The rates are expressed as millimoles of ferricyanide reduced per hour, per milligram of chlorophyll; the incident light intensities are expressed in lux. The reaction system was 0.0005M in potassium ferricyanide, 0.01M in potassium chloride, 0.10M in potassium phosphate buffer of pH 6.80, and 0.17M in sucrose. The reaction system (3.0 ml) contained chloroplast fragments equivalent to 100 mg/lit (1.1×10^{-4} M) chlorophyll. Illumination was provided by reflector-type incandescent bulbs; the reaction was run in flowing tank nitrogen at a temperature of 15°C.

by a potentiometric technique (10) as a function of light intensity in order to determine whether the virus affected the rate-limiting photochemical reaction, the rate-limiting dark reaction, or both (11).

The results of a typical experiment with plants raised under normal fertility are shown in Fig. 1. The slope of the curves at zero light intensity is proportional to the rate-limiting photochemical reaction; the asymptote approached by the curves at infinite light intensity is a measure of the rate-limiting dark reaction. The curves show that the rates of both processes are decreased in the chloroplast fragments from the infected plants. For more quantitative determinations, the data may be plotted in the form (light intensity)/(velocity) versus (light intensity). In this form straight lines are obtained in which the rate constant k_L for the limiting photochemical reaction is proportional to 1/intercept, and the rate constant k_D for the limiting dark reaction is proportional to 1/slope as discussed elsewhere (11). The values of the rate parameters as calculated in this way by the method of least squares are as follows: for control plants, $k_L = 0.12$, $k_D = 22.8$; for infected plants, $k_L = 0.07$, $k_D = 12.5$. Thus, both of the rate-limiting chloroplast reactions are decreased by approximately 50 percent (on a chlorophyll basis) in the infected plants.

These preliminary experiments indicate that the beet yellows virus could decrease photosynthesis and sugar production in the plant by a direct action on the chloroplasts rather than by some indirect effect on the photosynthetic mechanism or by interference with the translocation of carbohydrate in the phloem as has been shown in the case of the curly top virus of sugar beet. The results further indicate that the degree of yellowing of the infected leaves is not necessarily related to the severity of chloroplast injury, for the decrease in chloroplast activity noted is calculated on a chlorophyll basis.

JOHN D. SPIKES

Department of Experimental Biology,
University of Utah, Salt Lake City

MYRON STOUT

Field Crops Research Branch,
Agricultural Research Service,
U.S. Department of Agriculture,
Salt Lake City

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Hemagglutination after Immunization with Schistosome Antigens

Boyden (1) and recently Stavitsky (2) reported the adsorption of protein antigens on sheep erythrocytes treated with tannic acid and their subsequent hemagglutination by specific antisera. This technique was adapted to the antigen-antibody system in schistosomiasis. Agglutination of living cercariae of *Schistosoma mansoni* has been previously reported in the serology of schistosomiasis by Liu and Bang (3), Standen (4), and Stirewalt and Evans (5). In our investigations agglutination was observed in some but not all samples of normal, full-strength, inactivated serum of man, horse, cow, sheep, steer, goat, dog, hamster, rabbit, and pig. In the sera of 13 vertebrate species immunized with frozen cercariae of *S. mansoni*, *in vitro* agglutination of living cercariae was observed during the course of immunization (6). The agglutinin titer for living cercariae varied from 1:8 to 1:128, and a more sensitive and specific technique for the detection and titration of these antibodies was desirable.

The method of conducting the hemagglutination test (7) followed Boyden (1). Sheep cells in Alsever's solution were washed in buffered saline (pH 7.2) and incubated with a 1:20,000 dilution of tannic acid for 10 min at 37°C. The packed tanned cells were then exposed to 5 vol of a 1:5000 dilution by weight of lyophilized cercariae of *S. mansoni* (0.001 mg of lyophilized cercariae per 5 ml of saline buffered at pH 6.4) for 15 min at room temperature. Coated cells were adjusted to a 2-percent suspension in 1:250 normal rabbit serum. Serial dilutions were made in 1:100 normal rabbit serum. One drop of antigen-treated cells was added to each tube with an Ives dropping pipette. The test was read after 2 hr and after the cells had remained at room temperature (23°C) overnight.

Hemagglutination titers were obtained for the sera of 16 rabbits immunized by six intravenous injections administered twice weekly for 3 wk with various stages of the life-cycle of *S. mansoni* and *Schis-*

Table 1. Hemagglutination by rabbit serum after immunization with antigens from stages of the life-cycle of *S. mansoni* and *S. douthitti*.

Antigen	No. injected	Hemagglutination titer
Male worms, <i>S. douthitti</i> *	230, 585	1:20, 1:80
Female worms, <i>S. douthitti</i> *	234	1:40
Male and female worms, <i>S. douthitti</i> *	218	1:160
Male and female worms, <i>S. douthitti</i> †	3 ml of 1:100 by weight	1:40
Female worms, <i>S. mansoni</i> *	345	1:160
Immature female worms, <i>S. mansoni</i> *	115	0
Male worms, <i>S. mansoni</i> *	530	1:160
Cercariae, <i>S. mansoni</i> *	12,000, 180,000	1:20, 1:80
Cercariae, <i>S. mansoni</i> †	6 mg in saline	1:20, 1:40
Cercariae, <i>S. mansoni</i> ‡	18,000, 21,000	1:80, 1:160
Miracidia, <i>S. douthitti</i> §	1900	0
Spleens of mice infected with many eggs of <i>S. douthitti</i> †	14.4 ml 1:100 by weight	1:640

* Saline homogenate. † Lyophilized antigen.

‡ Frozen cercariae in aquarium water. § Living miracidia in aquarium water.

tosomatium douthitti (Table 1), and for the serums of six hosts immunized twice weekly for 3 wk with various doses of frozen cercariae of *S. mansoni* (Table 2). Control serums of all the afore-mentioned hosts were negative by hemagglutination. All serums in Table 1 were tested a minimum of four times, and the titers recorded are averages. Since the number of rabbits immunized with a particular antigen is small, the titer for each animal immunized is listed separately.

One rabbit immunized with frozen cercariae of *S. mansoni* showed a titer of 1:80. This animal was reimmunized 3 mo later, and the titer rose to 1:640. Agglutinins were not detected in rabbits immunized with living miracidia of *S. douthitti* and with immature female worms of *S. mansoni*. Agglutinins were not detected in the serum of a rabbit immunized with an antigen prepared from a frog lung trematode (*Haematoloechus* sp.). The titer of 1:640 obtained after immunization with a lyophilized mouse spleen-egg antigen was unexpected, since this serum showed no *in vitro* activity against living cercariae and very little activity in immobilizing miracidia (8).

Although saline extracts of frog lung trematodes have been used as skin-testing antigens in schistosomiasis (9), antibodies could not be detected by hemagglutination after immunization. The hemagglutination test for this series of serums was more sensitive than the CHR (Cercarien-hüllen Reaktion of Vogel and Minning, 10) in detecting antibody; with one exception (spleen-egg antiserum), they were less sensitive than the miracidium immobilization test (8).

In Table 2, the titers of serums for agglutination of living cercariae of *S. mansoni* are compared with hemagglutination titers. *In vitro* agglutination tests with cercariae of *S. mansoni* were made in nine-depression Pyrex spot plates. Into each depression 0.5 ml of each serum dilution, plus 1 drop of Penicillin G (4000

units/ml), 1 drop of Streptomycin sulfate (0.5 mg/ml), and 1 drop of concentrated cercariae were added. Serums were diluted with 10-percent Ringer's solution, and control tests were made simultaneously with the diluent. Spot plates were placed in a moist chamber at room temperature (24° to 26°C), and readings were made the following day. Except for the chicken and pig, hemagglutination titers were much more sensitive.

As is noted earlier, the inactivated serums of several normal mammals agglutinated living schistosome cercariae. These serums were not titrated at this time. Approximately 1 year later, after these serums had been thawed and frozen many times, the normal and immune serums of the horse, cow, goat, and pig were retested. Agglutinins in normal serums were observed only in the horse, at a titer of 1:8, and in all immune serums at the same or higher titer (Table 2). The agglutination of cercariae in normal serum is probably caused by a non-specific agglutinin, since all normal serums were negative by hemagglutination.

The hemagglutination titer obtained from day to day for a single serum may vary more than twofold. Fifteen hemagglutination tests of a single immune horse serum were made over a period of several

Table 2. Comparison of agglutination and hemagglutination titers in animals immunized with cercariae of *S. mansoni*.

Host	No. of cercariae injected	Agglutination titer	Hemagglutination titer
Chicken	6,000	1:64	1:80
Cow	40,500	1:256	1:1280
Goat	26,000	1:64	1:5120
Horse	40,500	1:32	1:1280
Pig	25,000	1:128	1:320
Rabbit	18,000	1:32	1:160

months. Except for the first two tests where the titer dropped from 1:12560 to 1:320, the titers of 12 other tests fluctuated between 1:640 and 1:2560 (three tubes). The average titer for all tests was 1:1280. This titer was obtained in six of the 15 tests. Experiments with cells of different sheep, batches of normal rabbit serum, and lots of tannic acid by various manufacturers indicated that these variables were not responsible for fluctuation in the titer. The sensitivity of the test may vary with the solubility of the cercarial antigen used to coat the sheep red cells, since several batches of cercarial antigen were used. Work is in progress to obtain a soluble cercarial fraction that may be superior to the present antigen, and preliminary hemagglutination studies with human serums are being conducted.

IRVING G. KAGAN

Zoological Laboratory, University of Pennsylvania, Philadelphia

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3 May 1955

Effect of DDT on Enzymatic Oxidation and Phosphorylation

Despite numerous attempts to elucidate the mode of action of DDT [2,2-bis(*p*-chlorophenyl)-1,1,1-trichloroethane] on adult houseflies, it must be recognized that this phenomenon has not yet been explained. Sacktor (1) reported that DDT inhibited cytochrome oxidase of houseflies, and suggested (2) that one of the explanations for the resistance of adult flies to the insecticide might be the greater oxidase activity developed in resistant strains. Recently Morrison and Brown (3) summarized much of the literature on this subject and reported DDT inhibition of cytochrome oxidase from American cockroaches. In the course of our search for DDT-sensitive reactions of adult houseflies we have discovered an effect of DDT that appears to be different from any reported previously (4). This effect consists of DDT-inhibition of oxidation of citric acid cycle intermediates, and of oxidative phosphorylation, when oxidation and phos-

phorylation are catalyzed by subcell particles from adult houseflies. The inhibition occurs at concentrations of DDT at which cytochrome oxidase appears to be unaffected.

Two hundred and fifty well-fed houseflies (5), *Musca domestica*, of mixed sex, that had been previously anesthetized by chilling in the cold room, were gently ground for 2 min in a mortar with 10 ml of homogenizing medium. The homogenizing medium was adjusted to pH 7.4 and contained 0.1M potassium phosphate, 0.25M sucrose, and 4 μ moles/ml each of pyruvate, citrate, α -ketoglutarate, succinate, and malate, which were added as preservatives of the particles. The resulting brei and a subsequent 5-ml rinse was squeezed through 8 thicknesses of No. 40 cheesecloth into a 15-ml plastic centrifuge cup. Immediately after this, the cellular debris and chitin were removed by sedimentation at 460 g in a refrigerated Servall centrifuge for 3 min. The particulate fraction was separated from the decanted low-speed supernatant by centrifuging at 12,800 g for 5 min. The particles were suspended in 5 ml of buffer and resedimented at 12,800 g for 5 min. The washed fraction was dispersed in 8.5 ml of homogenizing medium for addition to Warburg flasks. All equipment and solutions were prechilled in ice before use, and all preparatory steps, other than centrifugation, were conducted in a cold room. Microscopic examination of the particulate preparations showed a uniform field containing small particles that were stained with Janus green B. It is to be noted that when ascorbate was used as the principal substrate, each flask also contained 1 μ mole of each of the substrates included in the homogenizing medium.

It may be seen in Table 1 that inhibition of oxidation of a substrate mixture, and of oxidative phosphorylation, was virtually complete at $5 \times 10^{-6}M$ (17.7

Table 2. Comparison of effect of DDT on ascorbate oxidation with effects on oxidation of citric acid cycle intermediates and phosphorylation by subcell particles from houseflies.* TCA denotes equimolar mixture of pyruvate, citrate, α -ketoglutarate, succinate, and malate.

Substrate (μ moles)	Added cytochrome c conc. (M)	DDT conc. (M)	O ₂ uptake (μ g atoms O ₂ /hr)	Phosphorylation (μ moles P/hr)
55 TCA [‡]	0		12.5	25
55 TCA [‡]	0	10 ⁻⁴	1.5	- 3
55 TCA [‡]	8×10^{-5}		16.2	31
55 TCA [‡]	8×10^{-5}	10 ⁻⁴	4.1	0
100 ascorbate + 5 TCA [†]	0		15.1	
100 ascorbate + 5 TCA [†]	8×10^{-5}		30.9	
100 ascorbate + 5 TCA [†]	8×10^{-5}	10 ⁻⁴	31.3	
5 TCA [†]	0		2.8	
5 TCA [†]	0	10 ⁻⁴	- 0.6	
5 TCA [†]	8×10^{-5}		2.5	
5 TCA [†]	8×10^{-5}	10 ⁻⁴	- 0.9	

* Except as noted in the table, the additions to the flasks were the same as those in Table 1.

[‡] Each value represents results from one Warburg vessel.

[†] Each value represents the average of results from two Warburg vessels.

ppm) DDT and that an appreciable effect occurred at $5 \times 10^{-6}M$ (1.77 ppm). It was demonstrated in numerous other tests that the particulate preparations catalyzed oxidation of each of the substrates used in these experiments. Therefore, the data indicate that DDT inhibits, directly or indirectly, oxidation of every compound included as substrate.

To determine whether the effect noted was dependent upon inhibition of cytochrome oxidase, the oxidation of citric acid cycle intermediates and the oxidation of ascorbic acid were compared with respect to their susceptibility to DDT inhibition. Experiments not reported here demonstrated that oxygen uptake in this system reached a maximum when 50 to 100 μ moles of sodium ascorbate was added to each flask and when the concentration of added cytochrome c was $8 \times 10^{-5}M$. These concentrations were therefore used for the experiment reported in Table 2. It is apparent from the data in Table 2 that at least one-half

of the ascorbate was oxidized through the cytochrome system, and it is reasonable to assume that most of it was so oxidized. Yet, under conditions in which the cytochrome system was loaded to a maximum, using ascorbate as the electron donor, no inhibition of oxidation was noted. In the same experiment, using the same particulate preparation, confirmation was obtained for DDT-inhibition of the oxidation of citric acid cycle substrates and of oxidative phosphorylation. In all of the experiments reported, this inhibition occurred in the presence or absence of added cytochrome c.

It does not appear that the DDT effects noted can be explained on the basis of an inhibition of cytochrome oxidase. Apparently DDT inhibits some other reaction involved in oxidation via the citric acid cycle; this occurs at DDT concentrations far lower than those at which cytochrome oxidase seems to be affected. Further work is obviously required to explain completely the data reported.

JOHN A. SACKLIN

L. C. TERRIERE

LEMAR F. REMMERT

Department of Agricultural Chemistry,
Oregon State Agricultural Experiment
Station, Corvallis

Table 1. Effect of DDT on oxidation of citric acid cycle intermediates and on phosphorylation by subcell particles from houseflies.*

Ethanol-DDT concentration	Citric acid cycle oxidation (μ g atoms O ₂ /hr)		Phosphorylation (μ moles P/hr)	
	Expt. 1	Expt. 2	Expt. 1	Expt. 2
Control	13.8	12.6	34	30
Ethanol, 0.316 percent	13.0	12.3	38	30
DDT, $1 \times 10^{-4}M$ (35.5 ppm)	1.5	1.5	0	1.5
DDT, $5 \times 10^{-6}M$ (17.7 ppm)	1.0	2.0	0	2.0
DDT, $1 \times 10^{-5}M$ (3.55 ppm)	8.0	9.5	18	22
DDT, $5 \times 10^{-6}M$ (1.77 ppm)	10.0	10.5	22	26
DDT, $2.5 \times 10^{-6}M$ (0.89 ppm)	12.0	11.7	35	29
DDT, $1 \times 10^{-6}M$ (0.355 ppm)	12.3	12.1	32	30

* Each value represents the average of results from two Warburg vessels. The reaction was carried out in a final volume of 3.0 ml containing 200 μ moles potassium phosphate, 175 μ moles tris buffer (Sigma 7-9), 500 μ moles sucrose, 0.06 μ moles cytochrome c, 10 μ moles MgSO₄, 10 μ moles ATPNa₂ (Sigma), 6 mg plasma albumin (Armour), 5 mg hexokinase (Pabst), 200 μ moles glucose, and 11 μ moles each of pyruvate, citrate, α -ketoglutarate, succinate, and malate as sodium salts; 0.25 ml of the enzyme preparation was added to each flask. Final pH 7.3 to 7.4. Centerwell contained 0.2 ml 20 percent KOH. When DDT was added (in alcohol solutions), the final ethanol concentration was 0.316 percent.

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5. We wish to thank Russell E. Siverly of the department of entomology for rearing the houseflies used in this study.

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Book Reviews

The Dancing Bees. An account of the life and senses of the honeybee. Karl von Frisch. Harcourt, Brace, New York, 1955. xiv + 183 pp. Illus. + plates. \$4.

This book is a translation of the 1953 edition of von Frisch's *Aus dem Leben der Bienen*. It includes much fine material not previously available in a comparable context in the English language. The translation is excellent, having been made by Dora Ilse of the University of Poona, India, one of von Frisch's students and herself a student of bees. The style is easy and such technical terms as are used are fully explained.

The first 40 pages, approximately, contain descriptions, with adequate illustrations, of the major features of the life-history and structure of honeybees. Such chapter titles as "The brood" and "The swarm" indicate the type of material contained in this section of the book. The next 100 pages are the heart of the book, containing a fine account of the work for which von Frisch has become famous. Such topics as the chemical senses, vision, orientation, and communication of bees are very interestingly discussed. The accounts of the dances concerned with communication are as excellent as could be expected. The last part of the book consists of miscellaneous short chapters on such matters as enemies and diseases of bees and other insect communities. Some of these chapters are so brief that they might better have been omitted.

CHARLES D. MICHENER
Department of Entomology,
University of Kansas

Elements of Servomechanism Theory. George J. Thaler. McGraw-Hill, New York-London, 1955. x + 282 pp. Illus. \$7.50.

This volume is planned as a textbook for a one-semester undergraduate course in servomechanisms. Operational calculus is avoided, and frequency-response methods are emphasized, in both polar and logarithmic form. Familiarity with differential equations is assumed. Of the 10 chapters intended for the course, seven have problems for assignment to students. The student's grasp of the material will be easier if he has had some network

theory. Indeed, many of the problems assume such background.

The author uses the problems to instruct the student in the field of carrier frequency servos and the compensation of such systems. This is questionable procedure: a few paragraphs on that subject would help even the brightest student. For instance (problem 4-3), the equation of a loaded parallel "T" network, with source impedance included, is a tedious derivation, and the mere instruction to "Derive appropriate transfer function" will probably not produce the form that is most instructive.

It is quite apparent that the material in the book has been used in actual classroom practice. The presentation is elementary, patient, and thorough. An interested college student should be able to follow the material easily. The book should fill the existing need for an elementary college textbook and should find wide use in the courses that are being set up in many schools.

CARLTON W. MILLER
Engineering Department,
Perkin-Elmer Corporation

Biology of Deserts. J. W. Cloudsley-Thompson, Ed. Institute of Biology, London, 1954. iv + 224 pp. Illus. 14s.

With increasing problems arising from world overpopulation, attention of scientists in various lines is turning to interdisciplinary study of marginal regions, particularly deserts, and their possibilities for occupation and exploitation, as was exemplified by the recent International Arid Lands Meeting in New Mexico, at Albuquerque and Socorro, 26 April-4 May [*Science* 121, 659; 122, 61 (1955)], and by the earlier symposium whose proceedings are published in this report—a conference on "The biology and productivity of hot and cold deserts," held in London, 25-27 September 1952, organized by the Institute of Biology and supported in part, as was the recent New Mexico gathering, by UNESCO funds.

Five topics were covered in the several sessions of the conference, as follows (the number of papers for each is given in parentheses): "Climate and physical environment" (4); "Plant ecology" (6); "Entomology and ecology" (5); "Eco-

nomic aspects" (4); "Mammalian physiology and ecology" (9). Six pages of discussions are also included.

The second half of the last subject (4 papers) is concerned with adaptability of one particular mammal, our own species. The conclusion is indicated that men of various races can, with proper precautions, live and work in hot arid country and in cold environments as well as in the humid tropics.

The four papers listed under "Economic aspects" deal with man-made deserts, desiccation caused by deforestation, cultivation, burning and overgrazing, and programs for halting the march of the deserts. Discussions of insects and of plant diseases are also particularly good to have.

These, and the other, general and biological, papers are all interesting and valuable, forming a most important compilation.

ERIK K. REED
National Park Service, Santa Fe

Solubilization and Related Phenomena. M. E. Laing McBain and E. Hutchinson. Academic Press, New York, 1955. ix + 259 pp. Illus. \$7.50.

Although our factual knowledge of the theoretically and practically important subject of solubilization has vastly increased during the last decade, it is still impossible to give an exact interpretation of the experimental results. The main reason is that knowledge of the intimate structure of micelles is lacking. This situation has led to many ad hoc interpretations of the experimental data.

Evidently there is a great need for a book on solubilization which summarizes systematically all experimental data and discusses the interpretations in a fair and critical way. McBain and Hutchinson have succeeded admirably in providing us with such a book, and it will be of great service to anyone interested in the subject.

After a concise treatment of the historical developments in Chapter I there is a brief description of solubilization as a sorption phenomenon in Chapter II. This is followed by a concise chapter dealing with the thermodynamic properties of solutions of colloidal electrolytes. Extremely valuable is the long Chapter IV (more than 100 pages), which summarizes and discusses in a systematic way the host of experimental data found in the literature. Many clear graphs facilitate the reading of this factual chapter. The various views dealing with the mechanism of solubilization are discussed in Chapter V. Phenomena related to solubilization as cosolvency, blending, and hydrotropy are presented in Chapter

VI. The last two chapters deal with the physiological aspects and some more general applications of solubilization. Appendix I gives a concise theory of light scattering, and Appendix II discusses briefly the behavior of polysoaps.

There are relatively few shortcomings in this book. It is somewhat surprising that no mention is made of potentiometric studies of colloidal electrolytes, although such data provide valuable information on the properties of colloidal electrolytes. The section dealing with emulsion polymerization (p. 129) is disappointing and very weak; no mention is made of the important theory proposed by Ewart and Smith in 1948.

Fittingly the book is dedicated to the late James W. McBain, the pioneer in the field of solubilization, who has contributed so much to its development. Some statements made by him are reproduced in the introduction.

I. M. KOLTHOFF

University of Minnesota,
School of Chemistry

Bibliography on Hearing. S. S. Stevens, J. G. C. Loring, D. Cohen, compilers. Harvard University Press, Cambridge, Mass., 1955. 599 pp. \$7.

This bibliography is an enlargement of an earlier one, *A Bibliography in Audition*, by G. A. Miller, R. Galambos, W. A. Rosenblith, and I. J. Hirsch. It contains more than 10,000 titles listed alphabetically by author and includes a scheme of subject classification.

The procedures used in the compilation are not specifically outlined in the preface, nor is there a listing of the particular fields intended to be covered, although it is mentioned that, in comparison with the former edition, this one places added emphasis upon deafness, ultrasonics, the effects of drugs on hearing, information theory, and the psychological and acoustical effects of music.

A necessarily sketchy examination of the titles themselves indicates that there is extensive coverage of general and theoretical aspects of hearing, of the phenomena of pitch, fatigue, and masking, and of the special fields of speech and music. There appears to be somewhat limited coverage of historical material, of the anatomy of the ear, of hearing in animals, and of problems of deafness. Other topics, such as the physics of sound, the effects of noise, auditory testing, and the phenomena of beats, combination tones, and sound localization, seem to have an intermediate status, with a fair degree of coverage.

The subject classification, which is at the back of the book, consists of a divi-

sion of the field into 315 topics and then under each of these a listing of the names of the authors whose relevant works are included in the bibliography. A person interested in a particular topic will look up the listed names and, when several articles appear under one name, must discover for himself which ones are concerned with his topic. This system is serviceable, despite its indefiniteness, but doubtless will evoke certain expressions of annoyance from its users.

It is made clear in the preface that the titles were assembled largely from secondary sources, and the usual errors from such a procedure are to be expected. I noticed only a few errors, mostly of a minor nature. Somewhat surprising is the listing "Tyndall, J. *Der Schall*" and the omission of this famous book in its original English. Errors noticed in the subject classification are of two sorts: some names listed are not to be found in the bibliography, and others are inappropriate. An amusing instance of the latter sort is the reference to articles by Cooseman on "Hearing in beetlers" under the topic "Animal studies; frequency range: invertebrates"; for beetlers are people who work in cotton mills—not members of the order Coleoptera.

This bibliography represents a great deal of exacting, routine work and will be of considerable service to students in the auditory field.

E. G. WEVER

Department of Psychology,
Princeton University

Integers and Theory of Numbers. Abraham A. Fraenkel. Scripta Mathematica, Yeshiva University, New York, 1955. 102 pp.

This volume, the author explains in the preface, is essentially a translation of the first part of his earlier book, *Mavo LeMathematika*, which was written in Hebrew and grew out of talks given by him, over a period of many years, as part of the adult-education program in Israel. It is to be followed by two more volumes of a similar nature, one on the fundamental concepts of modern algebra, the other on the theory of sets.

The four chapters are entitled "Natural numbers as cardinals," "Natural numbers as ordinals," "Theory of numbers," and "Rational numbers." The first, second, and fourth present a construction of the number system through the rationals. Many results are proved, but there is no attempt to provide a step-by-step development, such as is found in Landau's *Grundlagen der Analysis*. The third chapter discusses some of the well-known results and unsolved problems of

classical number theory. Throughout the book there are numerous references to more detailed treatments of various topics.

The foregoing remarks do not, however, do justice to the book. It is an attempt by a mathematician of wide and deep learning to give the intelligent layman some understanding of the nature of our number system and of mathematics in general. It will prove to be a difficult book for such a person, and I shall not try to predict how many there will be who will devote the necessary effort to the task. Those who do, however, will find it an enlightening and stimulating experience.

JOHN DYER-BENNETT

Department of Mathematics,
Purdue University

The Nitrogen Metabolism of Microorganisms. B. A. Fry. Wiley, New York; Methuen, London, 1955. ix + 166 pp. Illus. + plates. \$2.

In this little Methuen monograph B. A. Fry has achieved his aim: "to survey as comprehensively as possible the nitrogen metabolism of microorganisms and . . . to reflect current trends in modern biology." This book is a survey, and, like a surveyor, Fry covers a vast area going from one well-defined point to another with brief attention to the details between. The area of nitrogen metabolism has been covered well; if any major points have been omitted I was not aware of them. Those who might wish to get more details will find the list of references very complete. "Current trends in modern biology" are reflected especially in chapters on absorption of amino acids and on the mode of action of chemotherapeutic agents.

This monograph, for a modest cost, will provide all but a specialist in the field with a fine introduction to nitrogen metabolism.

S. G. KNIGHT

Department of Bacteriology,
University of Wisconsin

Biochemistry and Physiology of Protozoa. vol. II. S. H. Hutner and A. Lwoff, Eds. Academic Press, New York, 1955. xiv + 388 pp. Illus. \$9.

By virtue of their favorable characters as compared with other microorganisms and with a growing number of forms cultivable *in vitro* free from other organisms, Protozoa are becoming increasingly popular as "biochemical tools." Therefore, the appearance of the second vol-

ume of this series is highly timely. The present volume is composed of 10 articles written by 12 contributors, four British and eight American, each of whom has been engaged for a number of years in work related to the topic he deals with.

In the introduction, the background and general picture of Protozoa as biochemical and phylogenetic tools are discussed interestingly. "Comparative biochemistry of flagellates" reviews the nutritional requirements and chemistry of some of the organelles of certain mastigophorans. The third article brings to light all available information on the synthesis of starch in *Polytomella*. Nutrition and metabolism of free-living ciliates are discussed in the fourth and sixth chapters, while the relationships of the rumen ciliates to ruminants and of xylophagous flagellates to termites and woodroach are reviewed in the seventh article. The ninth chapter deals with the present state of our knowledge of the chemotherapy of malaria and other diseases caused by hemozoic protozoans. The last article on comparative studies on amebas and amebicides considers free-living and parasitic amebas with special reference to *Entamoeba histolytica*.

The organization and presentation are excellent. References are abundant and up to date. Typographical errors are remarkably small in number and of minor character. For example, "*A. quadrimaculatus*" (the genus name should have been given fully) following "*Aedes aegypti*" (p. 228) appears in the index as "*Aedes quadrimaculatus*" (p. 363). This book is an excellent summation of the present state of biochemistry in relation to certain protozoans. It, like the first volume, makes a highly useful reference book and guide for those who are or intend to be students of protozoology and biochemistry.

R. R. KUDO

Institute of Microbiology,
Rutgers University

Ciba Foundation Symposium on Chemistry and Biology of Pteridines. G. E. W. Wolstenholme and Margaret Cameron, Eds. Little, Brown, Boston, 1954. xiv + 425 pp. Illus. \$8.

The Chemistry and Biology of Pteridines is an account of a symposium on pteridines sponsored by the Ciba Foundation. This symposium consisted of 29 participants who had been invited by this foundation both to present formal papers and to contribute to informal discussion on the chemistry and biochemistry of this interesting class of compounds. This volume represents the first printed account of a symposium of this

type, and the 28 papers contained in it are indicative of the wide scope of work involved. The book is divided into two parts: the first part contains 16 papers on the chemistry of pteridines, and the second part has 12 papers dealing with the biological aspects.

The reader will find the book to be interesting partly because of the wide variety of subjects covered and the interesting nature of the informal discussion. The section on the chemistry of these compounds may not prove to have as wide an interest as those dealing with their biochemistry. The biochemical subjects discussed will be of interest to all students of biochemistry in view of the fundamental role that is played by folic acid and its derivatives in metabolism.

This book will prove of value to the biochemist, because it gives an over-all picture of the occurrence of these compounds, which are widely distributed in nature both as pigments whose functions are unknown and as essential parts of enzyme systems. The biological importance of many of these compounds remains unknown, and it is reasonable to expect that this book will stimulate more research on this interesting class of compounds.

E. L. R. STOKSTAD

American Cyanamid Company,
Lederle Laboratories

Chemisorption. B. M. W. Trapnell. Academic Press, New York; Butterworths, London, 1955. vii + 265 pp. Illus. \$6.80.

During the past 15 years there has been a great deal of important new work concerned with chemisorption on solids. As the author explains, this monograph was written to fill a gap in the existing literature on the subject in which neither a selective nor an exhaustive treatment is to be found. The happy result has been a lucid and concise exposition on chemisorption which is a delight to read and a model for scientific writing.

Particular effort appears to have been made to discuss numerous recent developments. The thoroughly up-to-date character of the book becomes immediately evident on examination of the literature references. More than half of all the scientific papers drawn upon in the text have appeared since 1940. Such topics as the application of the field emission microscope to investigations of the mobility of adsorbed layers, the relevance of Pauling's new theory of metals to the interpretation of their catalytic activity, and the role of the semiconductor properties of several oxides in the decomposition of N_2O are touched upon.

By an admirable economy in style and in organization, the abundant material on chemisorption is compressed into 10 chapters requiring fewer than 300 pages. Yet very little seems to have been omitted, and a nice balance is maintained in the presentation of experimental detail and theory. Space is even found to illustrate the bearing of chemisorption on heterogeneous catalysis, as is evidenced by the last two chapters on catalytic specificity and on the mechanisms of catalytic reactions. There is hardly a doubt that this attractive little book affords an excellent introduction to chemisorption for the nonspecialist reader. For the specialist, this work will be important because a leading investigator in the field attempts to summarize the position today of our understanding of the chemical interactions of atoms and molecules with solid surfaces.

G. E. BOYD

Oak Ridge National Laboratory

The Skin, a Clinicopathologic Treatise. Arthur C. Allen. Mosby, St. Louis, 1954. xv + 1048 pp. Illus. + plates. \$25.

The purpose of this book, according to the author, is to effect a better understanding between dermatologists and other practitioners of medicine. For those interested in dermatology and sufficiently familiar with histopathology, A. C. Allen certainly presents an extraordinarily well-prepared treatise and this in a field where unanimity of opinion is the exception. He chose the atlas type much like his monograph *The Kidney* in 8½ by 11½ in. format. Every chapter has an ample bibliography—in all there are more than 2000 references. Wherever systemic changes occur, aside from those in the skin, Allen describes and illustrates them lavishly, in this way linking the experience of the dermato-histopathologist with that of the general pathologist. He also gives excellent group discussions of entities in which his experience as a pathologist will stimulate dermatologic thinking.

His criticism of dermatologic terminology is shared by dermatologists. Correcting it will take much study and international cooperation, for which there has been no opportunity during the past 15 years. He offers no suggestions himself.

The field of allergic and eczematoid eruptions is not clearly presented, and at times Allen's remarks are at variance with generally accepted terminology and conceptions.

In covering therapy, the author is sometimes adequate. Frequently he confines himself to the newest and least tried medications that have not been generally

accepted. This refers especially to the use of steroids and antibiotics.

A little less than one-third of the book is devoted to tumors of the skin, and this part especially is liberally illustrated with clinical and microphotographs. The author has had an unusual opportunity to select cases from various hospitals and the Armed Forces Institute of Pathology and shows great skill in utilizing his material. Every phase has been well covered, the discussion of the pathology is clear and to the point, and the therapy follows the latest accepted principles.

The book as a whole shows superior technical execution. The photography is splendid, and the reproductions are without flaws. It deserves to be a reference volume in every hospital library and every pathologist's office, but trainees in dermatology will also greatly appreciate it.

WALTER TEICHMANN
Georgetown University

New Books

Agricultural Regions of the United States. Ladd Haystead and Gilbert C. Fite. Univ. of Oklahoma Press, Norman, 1955. 288 pp. \$4.

Quantitative Spectrochemical Analysis of Silicates. A scheme of quantitative dc arc analysis of the silicate minerals, rocks, soils and meteorites. L. H. Ahrens. Pergamon Press, London; Addison-Wesley, Cambridge, Mass. 1955. 122 pp. \$3.75.

Laboratory Identification of Pathogenic Fungi Simplified. Elizabeth L. Hazen and Frank Curtis Brown. Thomas, Springfield, Ill., 1955. 108 pp. \$5.50.

Brazing Manual. Committee on Brazing and Soldering, American Welding Soc. Reinhold, New York; Chapman & Hall, London, 1955. 193 pp. \$4.75.

Cardiolipin Antigens, Preparation and Chemical and Serological Control. WHO Monogr. No. 6. Mary C. Pangborn, J. O. Almeida, F. Maltaner, A. M. Silverstein, and W. R. Thompson. World Health Organization, Geneva, ed. 2, 1955 (Distr. by Columbia Univ. Press, New York). 52 pp. Paper, \$1.25.

Real Projective Plane. H. S. M. Coxeter. Cambridge Univ. Press, ed. 2, 1955. 226 pp. \$4.75.

Handbook of Private Schools. An annual descriptive survey of independent education. Porter Sargent, Boston, ed. 36, 1955. 1252 pp.

The Liver and Cancer. A new cancer theory. Kasper Blond. Wright, Bristol, Eng., 1955 (Distrib. by Williams & Wilkins, Baltimore). 220 pp. \$6.50.

Eternal Energies. John H. Ward. Richard Smith, Rindge, N.H., 1955. 286 pp. \$3.50.

Clinical Toxicology. Clinton H. Thienes and Thomas Haley. Lea & Febiger, Philadelphia, rev. ed. 3, 1955. 457 pp. \$6.50.

Introduction to Chemical Pharmacology. R. B. Barlow. Wiley, New York; Methuen, London, 1955. 343 pp. \$6.25.

Society and Medicine. Lectures to the Laity, No. XVII. Iago Galdston, Ed. International Universities Press, New York, 1955. 131 pp. \$3.

Harmonic Analysis and the Theory of Probability. Salomon Bochner. Univ. of California Press, Berkeley, 1955. 176 pp. \$4.50.

Geologische Bau der Sudamerikanischen Kordillere. Heinrich Gerth. Gebrüder Borntraeger, Berlin, 1955. 264 pp. DM. 52.50.

Elements of the Theory of Real Functions. J. E. Littlewood. Dover, New York, rev. ed. 3, 1954. 71 pp. Paper, \$1.35; cloth, \$2.85.

Scientific and Technical Societies of the United States and Canada. Natl. Acad. of Sciences-Natl. Research Council, Washington, ed. 6, 1955. 441 pp. \$7.50.

Grundlagen der Analytischen Chemie und der Chemie in Wässrigen Systemen. Fritz Seel. Verlag Chemie, GMBH Weinheim/Bergstrasse, Germany, 1955. 348 pp. DM. 29.

College and University Business Administration. vol. 2. Natl. Committee on the Preparation of a Manual on College and University Business Administration. American Council on Education, Washington, 1955. 267 pp. \$4.50.

Schools of Psychoanalytic Thought. An exposition, critique, and attempt at integration. Ruth L. Munroe. Dryden Press, New York, 1955. 670 pp. \$7.50.

Fundamental Fundamentals. Albert Brill. Philosophical Library, New York, 1955. 199 pp. \$3.75.

General Chemistry Workbook. Conway Pierce and R. Nelson Smith. Freeman, San Francisco, 1955. 255 pp. \$1.65.

Rome beyond the Imperial Frontiers. Mortimer Wheeler. Philosophical Library, New York, 1955. 192 pp. \$7.50.

Altes und Neues über konvexe Körper. Band III. H. Hadwiger. Birkhäuser, Basel, Switzerland, 1955. 115 pp. F. 13.50.

A Dictionary of Terms in Pharmacognosy and Other Divisions of Economic Botany. George Macdonald Hocking. Thomas, Springfield, Ill., 1955. 284 pp. \$9.75.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed, not to Science, but to the publisher or agency sponsoring the publication.)

Boletín Técnico. No. 7, *Segunda Contribución al Estudio de la Biología Floral de la Vid en Mendoza*, Pedro A. Zuluaga and Enrique Zuluaga; No. 8, *Materiales para la Biología de Margarodes Vitium Giard (Homop. Sternorrhincha) Parasito Radicular de la Vid en Mendoza*, Adrian Ruiz Leal; 85 pp. No. 9, *Determinación de Expresiones Vegetativas en Vid y su Aplicación en el Análisis de Ensayos Culturales*, Jose Vega and Juan M. Fox, 27 pp. No. 10, *Estudio Comparativo de Levaduras Champáneras*, Robert Vega, 40 pp. Universidad Nacional de Cuyo, Mendoza, Argentina, 1954.

Computer Directory, 1955. Computers and Automation, vol. 4, no. 6. Berkeley Enterprises, Inc., New York 11, 1955.

Graduate Theses 1944-1954. Comp. by Genevieve L. Reidy. College of Forestry, State Univ. of New York, Syracuse, N.Y., 1955. 116 pp.

The Southwestern Corn Borer in Arkansas. Bull. 553. L. H. Rolston. 40 pp. *A Comparison of Silage Preservatives.* Bull. 557. O. T. Stallcup. 16 pp. Agr. Expt. Sta., Univ. of Arkansas, Fayetteville, 1955.

The Sterling Story. Sterling Drug Inc., New York 18, 1955. 38 pp.

The Use of Woodchips and Other Wood Fragments as Soil Amendments. Bull. 593. Herbert A. Lunt. Connecticut Agr. Expt. Sta., New Haven, 1955. 46 pp.

Hospitalization of Mental Patients. A survey of existing legislation. 100 pp. \$1.25. *Alcohol and Alcoholism.* Report of an expert committee. WHO Technical Rpt. Ser. No. 94. 14 pp. \$0.30. *Legislation Affecting Psychiatric Treatment.* Fourth report of the Expert Committee on Mental Health. No. 98. 25 pp. \$0.30. World Health Organization, Palais des Nations, Geneva, 1955.

Experiments on the Possible Relationship between Soil Resistivity and Dowsing Zones. vol. III. S. W. Tromp. Foundation for the Study of Psycho-Physics, Leiden, Holland, 1955. 35 pp.

Study of Half-Chromatid Fragments in Meiosis of the Hybrid Bromus Trinii × B. Maritimus. Publ. in Botany, vol. 28, No. 1. Marta Sherman Walters. Univ. of California, Berkeley, 1955. 13 pp. 35¢.

Associations de Gyris dans les Etangs et les Lacs du Parc du Mont Tremblant. Adrien Robert. Univ. de Montreal, Montreal, 1955. 78 pp.

Pfizer Spectrum Index. Inserts 54 to 115. Pfizer Laboratories, Brooklyn 6, 1955. 53 pp.

Invariance of Field Theory under Time Inversion. Notas de Física No. 16. J. Tiomno. 24 pp. *Equacao de Proca em Coordenadas Esfericas.* No. 18. Samuel Wallace Mac-Dowell. 9 pp. *Mass Reversal and the Universal Interaction.* No. 19. J. Tiomno. 11 pp. *On the Mechanism of Fission at Very High Energy.* No. 20. Luis Marques. 3 pp. *A Casual Interpretation of the Pauli Equation (A).* No. 21. D. Bohm, R. Schiller, J. Tiomno. 28 pp. Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, 1954.

Signs of the Health Times. A condensed report of the public interest portion of the program at the 35th annual meeting of the National Health Council, 23-25 March, New York City. The Council, New York 19, 1955. 64 pp. \$1.

Fenix, Revista de la Biblioteca Nacional. No. 9. Biblioteca Nacional del Peru, Lima, 1955. 438 pp.

Boletín de Extension. No. 8, *Clarificación de los Vinos.* Aquiles Maveroff P. Universidad Nacional de Cuyo, Mendoza, Argentina, 1954. 13 pp.

Proceedings of the XIth General Assembly Held in the Hague from August 23rd to September 2nd, 1954. vol. X, pt. 8. *Administrative Proceedings.* International Scientific Radio Union, Brussels. 125 pp. \$2.

L'Amenagement des eaux douces de la recherche piscicole. R. Vibert. Conseil Supérieur de la Pêche, Paris, 1954. 49 pp.

Scientific Meetings

American Bacteriologists

A record attendance of 3016 scientists marked the 55th annual meeting of the Society of American Bacteriologists that was held 8-12 May at the Statler Hotel, New York.

The scientific program was divided as usual into four sections, corresponding to the divisions of the society—agricultural and industrial, general, medical, and physiology. At five concurrent sessions that occupied three full days, 390 papers were presented by members of the society. In addition to these short (10 minute) research reports, the scientific functions included several symposiums organized by the divisions of the society and a number of informal round-table discussions. The host organization, the New York City Branch, also arranged a number of scientific and educational exhibits, as well as the usual commercial exhibits of microbiological apparatus, equipment, supplies, and literature. The scientific exhibits were highlighted by a display of the recently developed agar-diffusion techniques for antibody analyses. A scientific exhibit that dealt with special equipment and the current status of microbiological problems under investigation at the Rockefeller Institute for Medical Research was presented in the library of the institute at a smoker attended by 330 visiting bacteriologists.

Although the diverse fields of microbiology were well represented by the scientific reports, particular emphasis was shown in the direction of medical bacteriology, with more than 40 percent of all papers falling into this category. Within this group, the growing attention that has been paid to studies in virology during the past few years was again evident. Other fields of interest to which a larger than usual number of reports were dedicated included cytology and cytochemistry, radiation biology, biosynthesis of complex molecules, and the intermediary metabolism of carbohydrates and proteins.

Of the many papers of outstanding interest, only a few can be mentioned here. Igor Tamm (Rockefeller Institute for Medical Research) reported further studies on the selective inhibition of influenza-B virus multiplication by benzimidazole derivatives. Progress in the development of a vaccine against type-2

dengue fever, and of combined dengue and yellow fever vaccines, was revealed by Schlesinger, Gordon, Frankel, Winter, Patterson, and Dorrance (Public Health Research Institute of the City of New York). Neutralizing antibodies to the virus of poliomyelitis were found by Bartell and Klein (Temple University School of Medicine) in the serums of some, but not all, domestic animals. The investigators concluded that antibodies to the polio virus are widely distributed in nature; they failed, however, to isolate the virus itself from these animals.

P. Gerber, C. G. Loosli, and D. Hamre (University of Chicago School of Medicine) presented evidence that antigenically different strains of human influenza virus are developed following repeated passage in mice immunized with the inactivated homologous agent; Gerber discussed the significance of these findings to the epidemiology and immunology of influenza in man. The isolation of keratin-digesting microorganisms from carious teeth by Schatz, Karlson, and Martin (National Agricultural College) suggested that these organisms are incriminated in the etiology of dental decay. Doudoroff, Palleroni, and MacGee (University of California) discussed the metabolism of fructose by a *Pseudomonas* species, and developed additional evidence for the existence of alternate pathways of carbohydrate oxidation.

Protection of x-irradiated animals against fatal septicemia by injections of spleen homogenate was reported by M. Silverman and L. Cole (U.S. Naval Radiological Defense Laboratory). In another study on radiation disease, Paulissen and Shechmeister (Washington University School of Dentistry) found that they could protect mice against postirradiation salmonellosis by previous vaccination. B. Bjorklund (State Laboratory of Bacteriology, Stockholm) and Isabel M. Mountain, K. Sprunt, and H. E. Alexander (Columbia University) reported the destruction *in vitro* of malignant human cells by antisera that are produced in animals repeatedly inoculated with such cells.

The subjects of the eight symposiums also reflected the diversity of interests that characterizes "microbiology" today: genetics and epidemiology, preservation by radiation, microbial toxins, electron transport, maintenance of cultures of

microorganisms, salmonella in food, problems in taxonomy, and rumen microbiology. A symposium on the early history of bacteriology in the New York area was arranged by the local committee.

At the annual banquet of the society, trends and problems in the training of bacteriologists were discussed by H. O. Halvorson in his presidential address. Halvorson then presented the 18th annual Eli Lilly Research Award in Bacteriology to Willis Avery Wood (University of Illinois) for his outstanding contributions in the field of bacterial metabolism. On the following day, Wood presented his award address to a joint meeting of all divisions.

At its business meetings, the council of the society initiated plans for the creation of an organization that would consist of members of the society with advanced professional standing in the various branches of microbiology. This organization will be empowered to set up certifying boards and to engage in other activities designed to raise the standards of performance in the several specialties. The Society of American Bacteriologists itself will continue to remain purely a scientific organization with membership open to any person interested in bacteriology and the stated aims of the Society.

DAVID W. WEISS

Rockefeller Institute for Medical Research

Meeting Notes

■ The 62nd annual convention of the Association of Military Surgeons of the United States will be held at the Statler Hotel in Washington, D.C., 7-9 Nov. The entire program has been devoted to the medical problems facing the military services and the nation in an atomic war.

The convention will be addressed by Lewis L. Strauss, chairman of the Atomic Energy Commission; by Frank B. Berry, Assistant Secretary of Defense (health and medical); by the surgeons general of the Army, Navy, Air Force, and Public Health Service; and by the medical chiefs of the Veterans Administration and the Federal Civil Defense Administration. The medical industries of the country also will choose a speaker to address the convention.

The first afternoon session will deal with the medical effects of nuclear warfare, including the characteristics of nuclear explosions, and the injuries caused by blast, heat, and radiation. The second day's program will be devoted to the principles of the care of mass casualties. The topics to be discussed include: protective measures; initial aid and rescue, sorting of casualties; emergency medical

care; cost of delays in treatment; the treatment of large numbers of blast, thermal, radiation, and neuropsychiatric casualties; the use of drugs, blood, and anesthetics in dealing with mass casualties; and public health, sanitation, and welfare problems.

The theme for the third day will be organization for the management of mass casualties. These last sessions will discuss the roles to be played by physicians, dentists, veterinarians, nurses, Medical Service Corps officers, Women's Medical Specialist Corps officers, and technical assistants. Ways and means will be proposed to train these people for atomic warfare. Finally, the methods for organizing sorting facilities, transportation, fixed and field hospitals, and holding units, to deal with thousands of casualties at one time, will be presented.

■ "Converting the old-growth forest" is the theme of the 55th annual meeting of the Society of American Foresters to be held in Portland, Ore., 16-19 Oct. Headquarters will be in the Multnomah Hotel.

Eleven technical sessions have been scheduled, and the papers to be presented will deal with forest management, silviculture, forest products, private forestry, forest economics, watershed management, forest recreation, forest-wildlife management, range management, public relations, and professional education in forestry.

■ The 8th annual scientific meeting of the Detroit Institute of Cancer Research will take place 17-19 Oct. in the auditorium of the Engineering Society of Detroit, 100 Farnsworth Ave., Detroit, Mich.

As an innovation this year the program includes two 1/2-day symposiums: the first will be directed to the general problem of host factors in resistance; the second will touch upon several facets of lung cancer.

There will be no registration fee; individuals who desire more information about this program may write to Dr. William L. Simpson, Detroit Institute of Cancer Research, 4811 John R St., Detroit 1, Mich.

■ The Illinois State Geological Survey will celebrate its 50th anniversary on 11 Oct. The anniversary program will center around two themes: "The Survey's response to the changing economic pattern of the past fifty years," and "The relation of mineral resource research in Illinois to the economy of the State." Among those attending will be delegates of national and local societies in geology and related fields and delegates of universities and colleges. During the forenoon of the following day the laboratories

will be open for inspection, and in the afternoon the Geological Survey will be host to the Association of American State Geologists.

The survey's program of research in the field and laboratory provides information of fundamental, economic, and educational value on the geology, geochemistry, geophysics, and mineral economics of the natural resources of Illinois. The full-time staff numbers 48 geologists; 22 chemists and physicists; 4 chemical, mechanical, and petroleum engineers; 2 mineral economists; 1 librarian; 2 editors; 30 technical assistants; and 20 nontechnical persons.

Headquarters for the organization are in the recently completed Natural Resources Building on the University of Illinois campus in Urbana. The building and accessory units were built solely for the research and extension work of the geological and natural history surveys at a cost of about \$3.5 million. Forty geological laboratories are equipped for specialized purposes.

■ The Clinical Congress of the American College of Surgeons convenes in Chicago, Ill., 31 Oct.-4 Nov. Attendance at this 41st annual meeting is expected to reach 10,000, with surgeons, physicians, and related medical personnel from all parts of the nation and a number of foreign lands present. J. Garrett Allen of Chicago is chairman of the local advisory committee on arrangements.

The program will include a résumé of the year's progress, including demonstrations and discussions of both current practical aspects of surgery and the new and experimental aspects. Noted surgeons and teachers will participate in the reports, panel discussions, and symposia. Exhibits on subjects of interest to surgeons, with information on fundamental research, diagnostic procedures, and new techniques, will be on display.

Alfred Blalock of Baltimore, Md., current president of the college, will preside at the opening evening session, at which Grayson L. Kirk, president of Columbia University, will be guest speaker. Frank B. Berry, Assistant Secretary of Defense (health and welfare), will give the Trauma oration on 3 Nov., speaking on "Mass casualties." On the final evening Warren H. Cole of Chicago will be installed as president for the coming year. His presidential address will consider "Surgical philosophy, old and new."

■ New York's first peacetime atomic energy exposition will be held 20 Oct.-3 Nov. 1955 at the Carnegie Endowment International Center on United Nations Plaza. Sponsored jointly by the Atomic Industrial Forum, the Fund for Peaceful Atomic Development, and the Carnegie Endowment for International

Peace, the display will be entitled "Man, the Atom, and the Future" and will stress the uses of atomic energy for the advancement of human welfare.

Exhibitors will be drawn from industrial organizations exhibiting in the first U.S. Trade Fair of the Atomic Industry, to be held in Washington, D.C., 26-30 Sept. [*Science* 122, 208 (29 July 1955)], and from a group of foreign firms to be invited by the sponsors of the exhibit. The exhibit, which will be conducted under the direction of the Atomic Industrial Forum, Inc., 260 Madison Ave., New York, will be open to the general public without charge.

■ The American College of Cardiology will hold its 4th interim meeting at the Hotel Claridge, Memphis, Tenn., 10-12 Nov. The scientific program will feature symposia on rheumatic fever, rheumatic heart disease, and vascular surgery. It will include speakers from the medical schools of Vanderbilt and Emory universities and the universities of Tennessee, Mississippi, Arkansas, and Kansas City, as well as the National Children's Cardiac Hospital of Miami, Fla. Further information may be obtained from the secretary, Dr. Philip Reichert, American College of Cardiology, Empire State Bldg., New York 1.

■ The Polish Academy of Sciences honored the memory of Albert Einstein on 18 May at a special session devoted to his scientific achievements. Speakers included Leopold Infeld, Michal Smialowski, and Stanislaw Loria.

Forthcoming Events

September

26-29. Assoc. of Iron and Steel Engineers, annual, Chicago, Ill. (Secretary, AISE, Empire Bldg., Pittsburgh 22, Pa.)

26-30. International Dairy Federation, annual, Bonn, Germany. (IDF, 154, rue Belliard, Brussels, Belgium.)

26-30. Atomic Industrial Forum and Trade Fair, Washington, D.C. (C. Robbins, 260 Madison Ave., New York 16.)

26-30. Colloquium on Deformation and Flow of Solids, Madrid, Spain. (H. L. Dryden, National Advisory Comm. for Aeronautics, Washington 25.)

26-1. Endocrine Soc., 7th annual postgraduate assembly, Indianapolis, Ind. (Postgraduate Office, Indiana Univ. School of Medicine, Indianapolis 7.)

27-1. International Symposium on Analogue Computers, Brussels, Belgium. (P. Germain, Institut de Physique Appliquée, Université Libre de Bruxelles, Bruxelles.)

28-29. Industrial Electronics Conf., Detroit, Mich. (G. Ferrara, 8106 W. Nine Mile Rd., Oak Park 37, Mich.)

28-30. Mississippi Valley Medical Soc., St. Louis, Mo. (H. Swanberg, 209-224 W.C.U. Bldg., Quincy, Ill.)



McGRAW-HILL

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30. American Medical Writers' Assoc., St. Louis, Mo. (H. Swanberg, 209-224 W.C.U. Bldg., Quincy, Ill.)

30-1. Council for International Organizations of Medical Sciences, 3rd general, Paris, France. (J. F. Delafresnaye, CIOMS, 19, avenue Kléber, Paris 16^e.)

30-2. Indiana Geological Field Conf., 8th, Clifty Falls State Park, Ind. (C. F. Deiss, Dept. of Geology, Indiana Univ., Bloomington.)

October

1-9. International Food Fair, Cologne, Germany. (International Trade Fair Staff, USDA, Washington 25.)

3-6. Soc. of Exploration Geophysicists, 25th annual, Denver, Colo. (C. Campbell, SEG, 624 S. Cheyenne, Tulsa, Okla.)

3-7. American Inst. of Electrical Engineers, fall general, Chicago, Ill. (N. S. Hibshem, 33 W. 39 St., New York 18.)

4-6. American Meteorological Soc., Stillwater, Okla. (K. C. Spengler, 3 Joy St., Boston 8, Mass.)

4-6. International Assoc. of Milk and Food Sanitarians, Augusta, Ga. (H. L. Thomasson, IAMFS, Box 437, Shelbyville, Ind.)

6-8. Optical Soc. of America, Pittsburgh, Pa. (A. C. Hardy, Room 8-203,

Massachusetts Inst. of Technology, Cambridge 39.)

6-8. Soc. of Industrial Designers, 11th annual, Washington, D.C. (S. G. Swing, SID, 48 E. 49th St., New York 17.)

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10-12. American Oil Chemists' Soc., Philadelphia, Pa. (Mrs. L. R. Hawkins, AOCS, 35 East Wacker Drive, Chicago 1, Ill.)

10-12. National Prestressed Concrete Short Course, 1st, St. Petersburg, Fla. (A. M. Ozell, Civil Engineering Dept., Univ. of Florida, Gainesville.)

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(See 19 August issue
for comprehensive list.)

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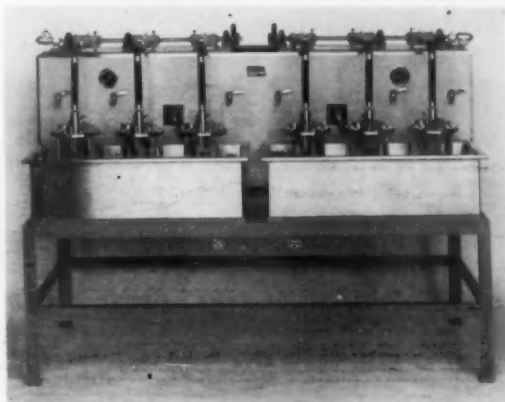


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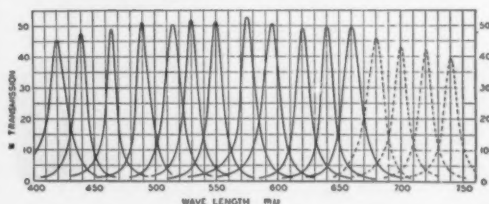
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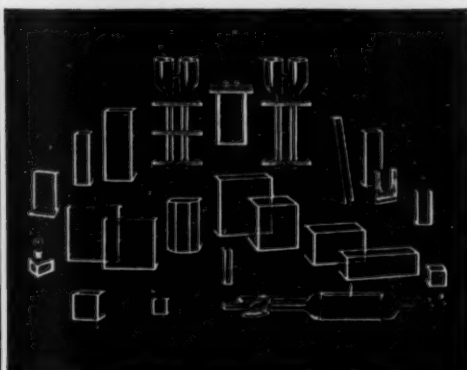
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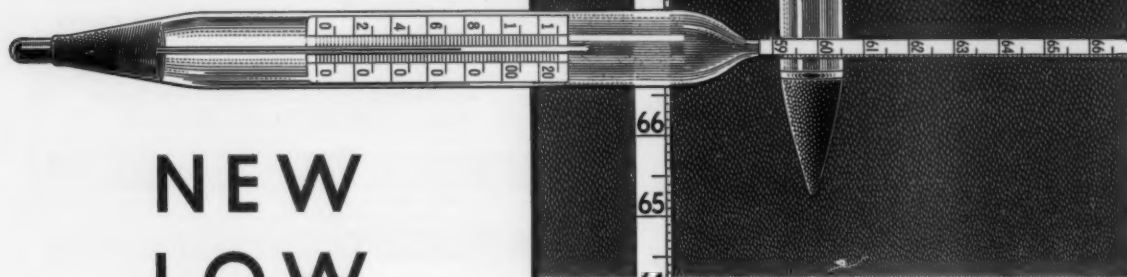


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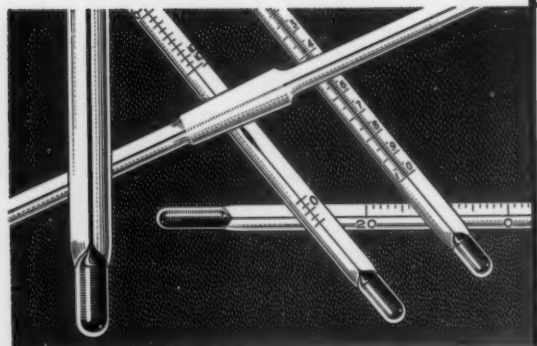
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At the old prices these instruments were an excellent value, but now at the new, low prices they are no less than a sensational bargain.

N.B.S. Specifications are minimum standards for Kimble Thermometers and Hydrometers.

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